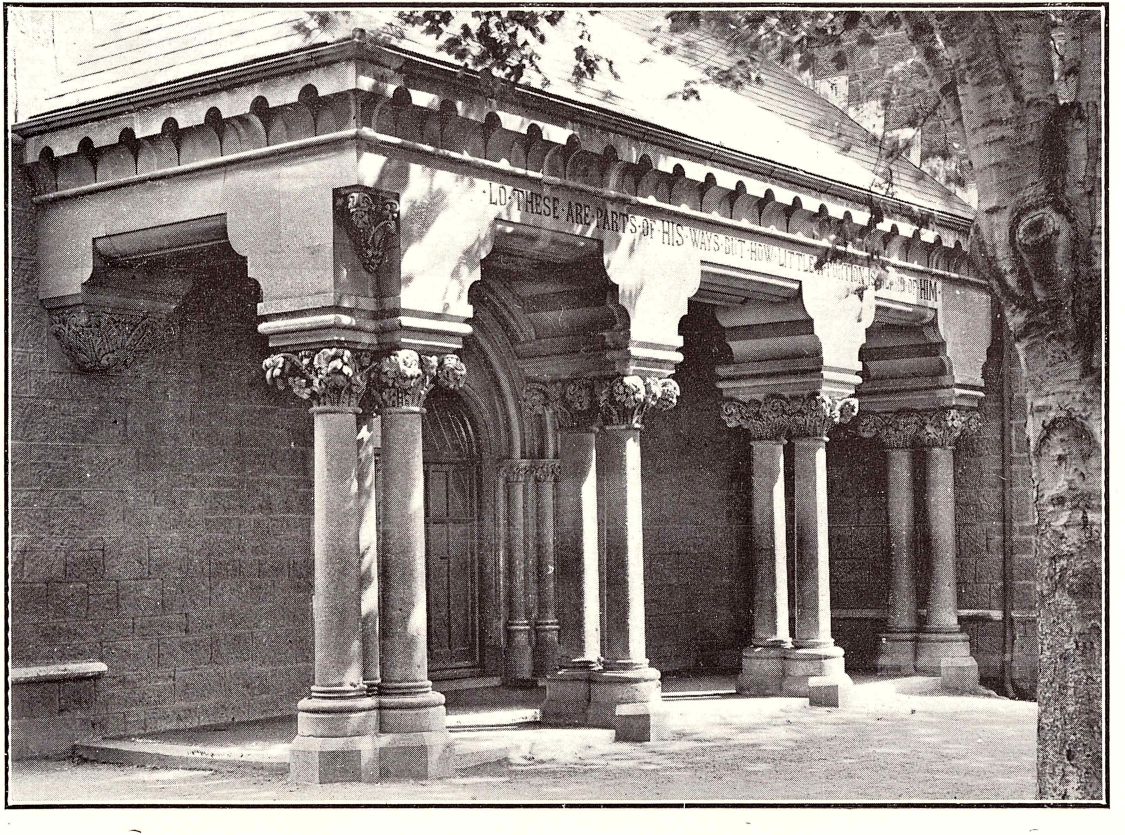
Natural History of Canterbury.

NATURAL HISTORY
OF
CANTERBURY

Issued by the
Philosophical Institute of Canterbury

A SERIES OF ARTICLES ON THE EARLY HISTORY OF THE PROVINCE AND ON THE HISTORY OF SCIENTIFIC INVESTIGATION, UP TILL 1926, AS WELL AS ON SOME RESULTS OF THIS INVESTIGATION.

R. SPEIGHT, ARNOLD WALL and R. M. LAING
HONORARY EDITORS



Entrance to the Canterbury Museum.

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PREFACE.

IN 1915 it appeared to certain workers in the Natural History of Canterbury that the time was ripe for a volume summarizing the work of investigators up to date. Owing to war conditions the matter was left in abeyance. In 1925 it was again brought before the Canterbury Philosophical Institute and a committee set up to carry out the work.

It is just over seventy-five years since the province of Canterbury was founded; and this publication will suitably mark the event. The work includes short biographies of leading men of science who have passed away, and a complete conspectus—so far as the limits of space admit—of the progress and results of scientific investigation within provincial limits, from the time of arrival of Captain Cook down to the present. Where possible, the recording of systematic results has been avoided and the articles are as free from technicalities as they can be made without sacrifice of scientific accuracy, in order that they may be readily understood by the reading public. The volume will thus be of use to all those wishing to obtain an authentic account of the different phases of the Natural History of the Province. Introduced, as well as indigenous, forms of life have been dealt with. The early history of the province, of survey and exploration, the acclimatisation of stock, fish, the botany of Banks Peninsula, the plains and the mountains, various branches of zoology (native birds, native fish, entomology), forestry (native and introduced timber trees), geology, physiography, agriculture, etc., have all been dealt with by recognised experts. The volume is therefore a mine of otherwise often inaccessible information for students, teachers, and scientists.

The Canterbury Philosophical Institute has already two works to its credit, the Index Faunae Novae Zealandiae (Hutton) 1904; and The Subantarctic Islands of New Zealand (Chilton) 1909. It is hoped if opportunity offers to continue the series dealing more at length with the subjects discussed in the Natural History of Canterbury.

ROBT. M. LAING.

Pres.; Phil. Inst. of Canterbury, 1927.

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"Nature never did betray
The heart that loved her: 'tis her privilege
Through all the years of this our life, to lead
From joy to joy; for she can so inform
The mind that is within us, so impress
With quietness and beauty, and so feed
With lofty thoughts, that neither evil tongues,
Rash judgments, nor the sneers of selfish men,
Nor greetings where no kindness is, nor all
The dreary intercourse of daily life,
Shall e'er prevail against us, or disturb
Our cheerful faith, that all which we behold
Is full of blessings."

—Wordsworth.

Natural History of Canterbury.

Introduction.

The Province of Canterbury, whose Natural History is described in this work, consists of an irregular parallelogram a little over 200 miles in length and about 70 in breadth, running roughly N.E. and S.W. and lying between the main chain of the Southern Alps and the sea, so that it includes an area of about 15,000 square miles. Bounded as it is by the high Alps on the N.W., the sea on the S.E., the Clarence River (for a great part of its course) and the Conway, on the N.E., and the Waitaki River on the S.W., it forms a very natural unit, self-contained, symmetrical, and distinguished by its special climate and geological history and by certain unique physical features from all the other Provinces of New Zealand. It supports a population of 213,000, and of these the Capital City of the Province, Christchurch, contains 118,000.

Immediately to the east of the main divide of the Southern Alps, all along its north-western boundary, lies a belt of mountain country, from thirty to forty miles broad, in which parallel ranges of diminishing altitude succeed one another till the Canterbury Plains are reached. The rainfall, which is fairly heavy on the divide, gradually decreases along the West to East line, and the climate of the easternmost Alps, the foothills and the plains themselves, is distinctly a dry one. The physiognomical characters of the whole province are thus determined. Along the line of the divide the valleys of the great snow-fed streams are usually richly clothed with forest (mostly beech), but as the dry eastern belt is approached the natural covering

consists more of grass, scrub, and more or less xerophytic vegetation, while the mountains themselves carry less and less snow, glaciers disappear, and the characteristic yellow or grey colour-scheme of Eastern Canterbury asserts itself more and more and finally becomes dominant.

At the northern end of the Province the country is hilly for 60 or 70 miles, and at the southern end for 30 or 40 miles, while the intervening area consists of the remarkable Canterbury Plains, a belt about 100 miles long and from 30 to 40 broad which includes the richest land in New Zealand. Ease of access and absence of forest gave this area a long start over the rest of the Colony and it has been the leading agricultural Province since the earliest days of its history. Cultivation, often intensive, has destroyed almost entirely the original character of this area; both its fauna and flora have been profoundly changed; certain species of birds have gone for ever, and it is only in the broad wastes of shingle through which the great rivers make their way seaward across the Plains that anything like the ancient appearance of the country remains to us.

About half-way between the Northern and Southern extremities the low coast line of the Plains is interrupted by the great volcanic protuberance of Banks Peninsula, formerly a heavily forested area except along the high ridges, but now largely cleared and affording very rich pasturage for all kinds of stock. Immediately to the south of it lies the large, shallow lagoon, Lake Ellesmere, separated from the sea by a narrow spit of shingle and fed by the Selwyn, Halswell, and other small rivers. The lower end of the Plains, upon which abut the Peninsula Hills, was formerly a very extensive swamp; this has long ago been drained and provides a rich agricultural soil. Of the few scattered patches of forest which white men found standing about the lower or eastern margin of the Plains, only the Riccarton Bush, near Christchurch, now survives.

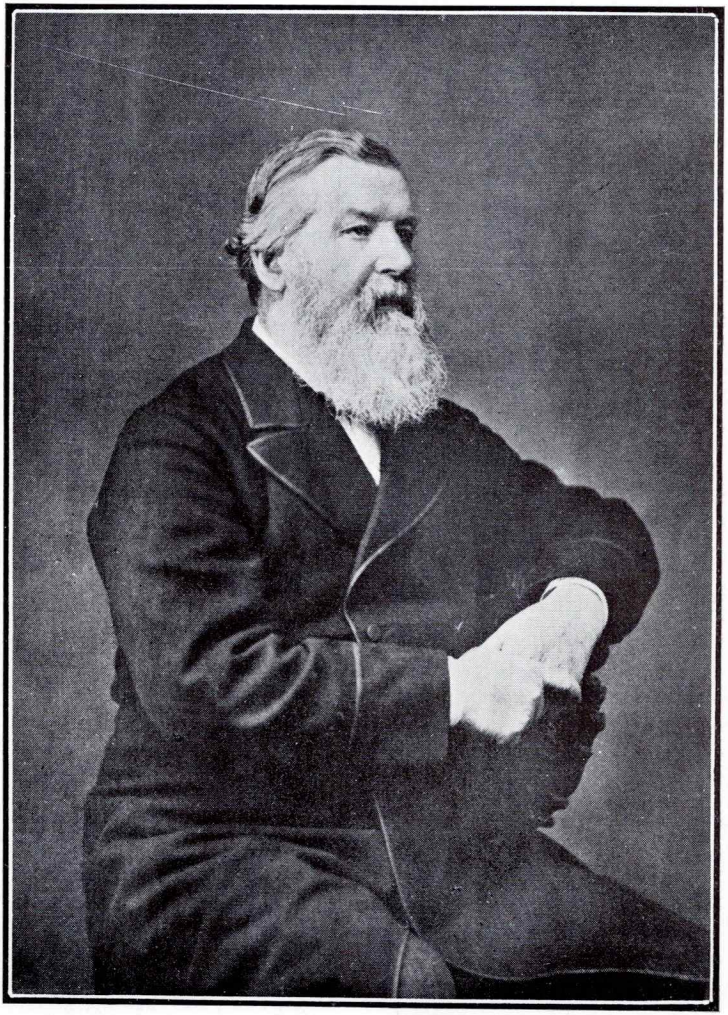
The scenery of the great mountain range which forms the North-western boundary of the Province

ranks among the noblest and most celebrated in the world. It includes the highest mountain in New Zealand; very numerous other peaks which challenge comparison for beauty of form and colour with Mt. Cook itself; three of the world's great glaciers,—the Tasman, Mueller, and the Hooker—and quite a host of other glaciers, all impressive and beautiful, at the heads of the Godley, Rangitata, Rakaia, and Waimakariri rivers; numbers of glorious lakes, large and small, mostly formed by glacial action, and some, like Coleridge, Tekapo, and Pukaki, of considerable extent; lofty, majestic peaks, shining with perpetual snow, adorned with magnificent hanging glaciers and lovely high-lying tarns; broad, spacious river-valleys whose enclosing walls are draped with sombre forests; and long chains of lower, drier, less spectacular mountains which exhibit a curious colour-scheme with a peculiar beauty of its own, and support a fauna and flora of unique scientific interest. This great alpine and sub-alpine region, with its austere and savage glories, makes a piquant contrast with the wealthy and well-peopled plains, whose fat pastures, abundant crops, healthy, well-bred stock, fine plantations and cosy homesteads offer a picture of agricultural and pastoral prosperity which can hardly be surpassed anywhere in the world.

Biographies of Men of Science, formerly resident in the Province.

JULIUS VON HAAST.
1824-1887.

John Francis Julius Haast was born in Bonn, Germany, on May 1st, 1824, his father being a wealthy merchant of that city. He was educated at various German schools and finally entered the University of Bonn, where he devoted considerable time to the study of geology. He afterwards travelled extensively in Europe, and in 1857 was appointed agent to an English firm sending German emigrants to New Zealand. In that capacity he set out for this country and arrived in Auckland in 1858, where he met Dr. von Hochstetter, the geologist on the staff of the Austrian scientific surveying ship *Novara*. The two men became intimately associated and they travelled together through the North Island and over parts of Northern Nelson. In 1859, Haast explored the west and south-west parts of that province and located deposits of both coal and gold. In 1860, he arrived in Canterbury and after a preliminary investigation of the geological conditions of the Lyttelton Tunnel, was appointed Provincial Geologist in 1861. For several years he was engaged in geological explorations, particulars of which are given on page 61 of this volume and as a result of his labours established a reputation as an explorer and as a geologist recognised throughout the whole civilised world. He was granted in 1862 the degree of Ph. D. by the university of Tübingen, and in 1867 was elected a Fellow of the Royal Society. This was perhaps the most active period of his life. Not only did he carry on a great deal of research on the physical geology of the province, and specially of its more remote districts, but he made extensive collections of plants in what was then a virgin land, and displayed an active interest in every section of natural history.



Sir Julius von Haast.

Numerous records of new genera and species of animals and plants were made by him. Above all, his papers on the Moa, specially in connection with the discoveries at Glenmark in 1866, attracted the widest attention, and he made important contributions to the ethnology of the district by examining critically the evidence bearing on the contemporaneity of the Moa and the Maori, particularly in the light of the discoveries he made when carrying out the excavation of the deposits of the Moabone Point Cave near Sumner. Along with eleven others he founded the Philosophical Institute of Canterbury in 1862, and occupied the position of President at the foundation and on numerous subsequent occasions.

His work in the '70's was more particularly associated with the Museum, which he founded in 1861, the building in the gardens being opened in 1870, and from then to the day of his death his thoughts were chiefly concerned in acquiring, and arranging the collections housed therein. His reputation in Europe, and his personal knowledge of many of the leading men of science gave him manifest advantages when negotiating exchanges, which he was able to make as the result of his discovery of great numbers of moa bones in different parts of the province. Besides being Director of the Museum, he was in 1876 appointed Professor of Geology at the recently established Canterbury College, and in spite of his routine work in connection with these two institutions he was able to continue his general field-work and scientific investigation into the natural history of the Province. He received further recognition of his work when he was granted in 1884 the Medal of the Royal Geographical Society of London, a patent of hereditary nobility by the Emperor of Austria, and in 1886 while acting as New Zealand Commissioner at the Indian and Colonial Exhibition in London he was created a K.C.M.G. However, he did not live long after this to enjoy his title for he died soon after his return to New Zealand on August 16th, 1887.

It is difficult to imagine a fuller life than that which he led between the time of his arrival in Canterbury and the day of his death. He took a most

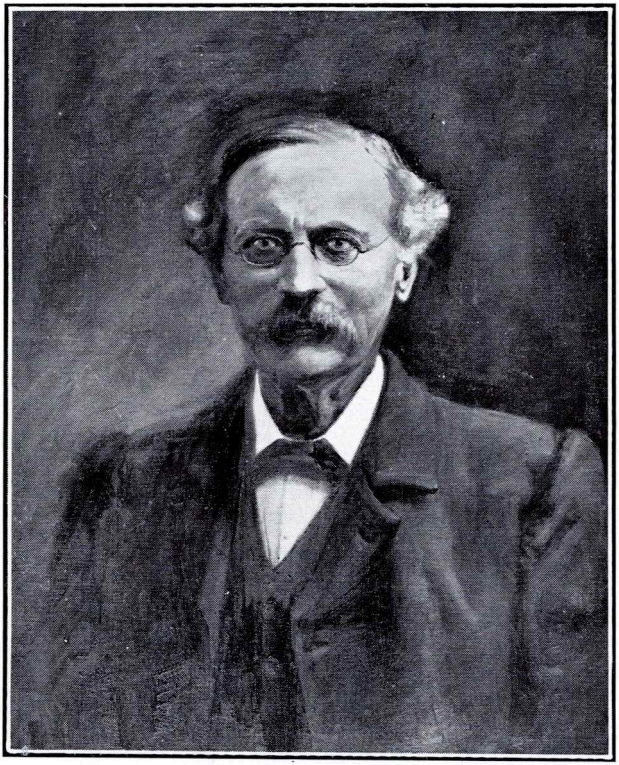
active part in all public movements for the good of the community, as well as carrying out his duties with an enthusiasm that he transmitted to all associated with him. He is a member of that band of men, of foreign nationality, but notably German, who contributed so much to the advancement of the British Colonies, both materially and scientifically, during the middle and later years of the nineteenth century. Among those associated with Australia and New Zealand may be mentioned von Tempsky, von Mueller, Leichardt, Ulrich, but Haast was probably the most distinguished of them all.

R. Speight.

FREDERICK WOLLASTON HUTTON.
1836-1905.

Frederick Wollaston Hutton, second son of the Rev. H. F. Hutton, was born at Gate Burton, Lincolnshire, November 16th, 1836. On his mother's side he came of a family (Wollaston) which claims to have given to the Royal Society more Fellows than any other. Thomas Vernon Wollaston (d. 1879), a friend of and fellow-worker with Charles Darwin, and author of *The Variation of Species, with special reference to the Insecta,* (1856), was his uncle, and it was from him that he first learned to take delight in the accurate observation of natural phenomena.

Hutton was educated at Southwell and the Naval Academy, Gosport, and served three years in the India Mercantile Marine. He then entered King's College, London, whence he was gazetted ensign in the 23rd Royal Welsh Fusileers in 1855 (Lieutenant 1857, and Captain 1862). He served in the Crimea, 1855-56, and was also present at the capture and relief of Lucknow, and at the defeat of the Gwalior mutineers under Sir Colin Campbell, near Cawnpore, November and December, 1858, and received the medal with two clasps for the campaign. In 1860 he entered the Staff College at Sandhurst, and passed out sixth in the examination list in 1861. His interests were however more scienti-



Captain F. W. Hutton.

fic than military, and, after having served for a year on the staff at Dublin as Deputy-Assistant Quartermaster-General, he resigned and sold out of the army in 1865, and emigrated to New Zealand with his wife and two children in January, 1866. At first he resided at Auckland and on the Waikato, but without achieving any success as a practical colonist. In 1871 he was appointed Assistant Geologist to the New Zealand Geological Survey, and removed to Wellington. In 1873 he became Provincial Geologist of Otago and Curator of the Otago Museum, and removed to Dunedin, being also appointed Professor of Natural Science at Otago University in 1877. Three years later he became Professor of Biology at Canterbury College in the University of New Zealand, and settled at Christchurch. This office he held until 1893, when he became Curator of the Christchurch Museum and lecturer in Geology and Palaeontology. In March, 1905, he left New Zealand on board the s.s. *Rimutaka* on a first visit to the old country after an absence of nearly forty years, and he died on board the same boat on the return journey within a few hours sail of Cape Town, and was buried at sea, October 27th, in lat. 30deg. 6min. S., long. 16deg. 52min. E.

Captain Hutton commenced his scientific work as a geologist and became a Fellow of the Geological Society in 1861. His first work in New Zealand was also in Geology. In 1875 he wrote a small Class Book of Geology and a little later, in conjunction with Professor Ulrich, he brought out a work on the Geology of Otago. His interest in and devotion to Geology continued throughout his whole life but his work in Canterbury was mainly in Zoology and he may well be called the Father of Canterbury Zoology. When he was appointed Curator of the Otago Museum in 1877 he found it necessary to classify and name the specimens in the collections and as the greater part of them were undescribed and no specialists were available he had to undertake the work of describing and naming the specimens himself. Naturally he started with the more important groups, the Birds and Fishes but at various times he dealt with practically all the subdivisions of the invertebrates—Hydroids, Worms,

Crustacea, Insects and particularly the Mollusca. The work thus forced upon him gave him a good general knowledge of the animal kingdom which proved of the greatest use when he came later on to discuss the wider questions of distribution and the origin of the New Zealand Fauna. In the performance of this systematic work he showed accuracy of observation, singular skill, tenacity of memory and adaptability and did good service in preparing the ground for others. His zoological papers in the *Transactions of the New Zealand Institute* and in other scientific journals are very numerous and deal with all classes of animals. To the birds he devoted special attention, and his important paper on the *Moas of New Zealand* (*Trans. N.Z. Inst.*, vol. xxiv) requires special mention. He also gave much time to the study of the Mollusca, and in addition to many papers in the Transactions of the New Zealand Institute published several catalogues of them, the most important of them being his *Manual of the New Zealand Mollusca* issued separately in 1880. In the same way he catalogued many of the different groups of insects. His systematic work was summed up and brought so far as possible to a conclusion in the *Index Faunæ Novæ-Zealandiæ*, edited by him and published by the Philosophical Institute of Canterbury in 1904, and a glance through its pages will show how large a number of the animals recorded from New Zealand have been named and described by him. Two works of a more popular nature written in conjunction with Mr. James Drummond deserve mention—viz. *Nature in New Zealand* and *The Animals of New Zealand*, the latter being a beautifully illustrated account of the air-breathing vertebrates of New Zealand.

But Captain Hutton was far more than a systematist, and as far back as 1873 he dealt with the origin of the fauna and flora of New Zealand in a paper *On the Geographical Relations of the New Zealand Fauna, (Trans. N.Z. Inst.* v. p. 227). He returned to the subject again in 1884 and 1885, and a concise and judicial summing-up of our knowledge of the subject will be found in his introduction to the *Index Faunæ Novæ-Zealandiæ.*

As a teacher, Captain Hutton was most successful. His lectures were particularly clear and to the point and by an avoidance of detail he succeeded in emphasising the essential points and in inspiring his students with his own enthusiasm and inducing them to follow his own methods. Many of them have since become active workers on the Natural History of New Zealand.

During the whole course of his career Captain Hutton gave much thought to the fundamental questions of biology. In 1861 he wrote a review of Darwin's *Origin of Species* for the *Geologist* which showed that even thus early he had grasped and accepted the fundamental principles of the theory of descent. This elicited a cordial letter of thanks from Charles Darwin which Hutton highly prized. It is preserved in the Canterbury Museum. In 1899 his work *Darwinism and Lamarckism, Old and New* was published simultaneously in London and New York. His presidential address at the Hobart meeting of the Australasian Association for the Advancement of Science in January, 1902, was entitled *The Lesson of Evolution* and was published as a separate volume in London in 1902. After his death, a revised edition with a biographical notice and an appendix containing his contribution *What is Life* from the *Hibbert Journal* for October, 1905, was printed for private circulation in 1907.

In 1903 after the reconstruction of the New Zealand Institute Captain Hutton was elected the first President and after his death the governors of the New Zealand Institute, on the initiative of the Philosophical Institute of Canterbury, and with the assistance of the Government of New Zealand raised a fund known as the Hutton Memorial Fund from which grants in aid of researches in Natural Science may be made, and caused a bronze medal to be struck, the Hutton Memorial Medal, which is conferred at intervals in recognition of specially valuable research work in Zoology, Botany or Geology.

Chas. Chilton.

THOMAS HENRY POTTS.
1824-1888.

Canterbury is indebted to Thomas Henry Potts in more ways than one. He is remembered in these days mainly on account of an admirable little book he published in Christchurch with the title *Out In the Open, a Budget of Scraps of Natural History Gathered in New Zealand*, but few people now know that he was a pioneer of scenic and natural history reserves and of forest conservation, and that he helped in other directions to build up this province.

He was born in England in 1824. He was engaged in the gun-making industry in Birmingham, where he conducted a successful business. When he was twenty-nine years of age, he left England in the John Taylor to come to the new settlement in Canterbury three years after the First Four Ships arrived. One of those who felt that Canterbury should be made "a slice of Old England," he gave that idea concrete expression. Before he left, he inquired as to the most suitable English plants to grow around the settlers' homes, and he brought with him a large number of azaleas, rhododendrons, ferns, trees, and other plants. These were the first consignment of the kind received in the province. They were the nucleus of his garden at the corner of Tuam Street and Antigua Street, Christchurch, which supplied seedlings for the Public Gardens, and which, with his enthusiasm, fostered a taste for horticulture and a love for English plants that still characterise this city.

In 1856, he bought Ohinetahi, a lovely property in Governor's Bay, where he made a picturesque home. It was the headquarters of many expeditions over the hills, on to the Canterbury Plains, and to lakes and forests where natural history was particularly interesting. Spending most of his time in the open, it was his practice day by day to make notes of his observations. From these, he wrote natural history articles for the *Lyttelton Times, The Field,* London, and *The New Zealand Country Journal.* He collected them later, revised them, and published them as *Out In the Open* in 1882, dedicating the book to Sir George

T. H. Potts.

Grey. He wrote gracefully and vividly; and as he was a careful observer, *Out In the Open* occupies a prominent place amongst old books relating to New Zealand. Bibliophiles give high prices for copies of it. Several papers by him in early editions of the *Transactions of the New Zealand Institute* were read before the Canterbury Philosophical Institute or the Wellington Philosophical Society. He gave most attention to birds, particularly native birds, but dealt with insects, plants, and the Maoris. He generously supplied Sir Walter Buller with many notes for *A History of the Birds of New Zealand.*

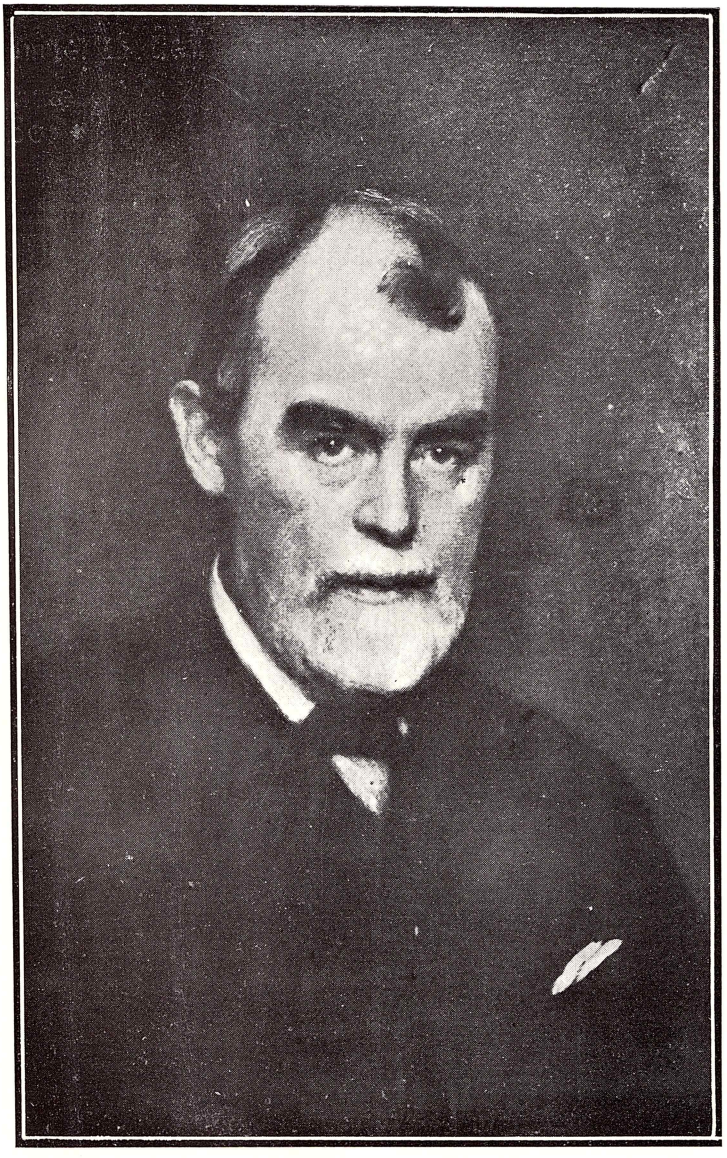
As early as 1878, he urged that national domains should be established. Ten years before that, he brought forest conservation before Parliament. He was the first to suggest that Resolution Island should be set aside as a park or a domain, "where the animals should be molested under no pretence whatever."

He was elected by the Port Victoria district to the Canterbury Provincial Council in 1866, and he sat on the Council until the provinces were abolished in 1876. As one of the original members of the Board of Governors of Canterbury College, appointed in 1873, he helped to lay the foundations of the collections in Canterbury Museum. From 1866 to 1870, he represented the Mount Herbert electorate, which included his home at Governor's Bay, in the House of Representatives. He died in Christchurch on July 27, 1888, soon after a visit to the Chatham Islands, to see what the group could produce.

James Drummond.

SAMUEL BUTLER.
1835-1902.

Samuel Butler was born in 1835, son of the Rector of a Nottinghamshire parish and grandson of the famous Dr. Samuel Butler, headmaster of Shrewsbury School and later Bishop of Lichfield. He was educated at Shrewsbury and St. John's College, Cambridge, which he entered in 1854 and left in 1859. He travelled fairly extensively in Europe during vacations, visiting



Samuel Butler.

Italy, Switzerland, Germany and France. His father's desire was that he should become a clergyman, but this he could not honestly do.

He left for New Zealand in 1859 and arrived at Lyttelton in 1860. His experiences on the voyage and subsequently are narrated by him with much humour and shrewdness in his *First Year of the Canterbury Settlement.* At the time of his arrival the best sheep country was already taken up and he made several journeys—up the Hurunui, the Waimakariri, and the Rakaia—before he decided to take up a small run on the Rangitata. Here he built a V hut and was living in it by June, 1860. He eventually took up the whole run, about 8000 acres, which he named Mesopotamia, and built the cob whare, thatched with snow grass, which remained in a serviceable condition till 1925. This was his home till he left New Zealand in 1864. The Christchurch *Press* was established in 1861 by J. E. Fitzgerald, a close friend of Butler's, and he frequently contributed to it and was once in charge of it in Fitzgerald's absence, though he was never the regular editor.

The rest of Butler's life belongs to the world; he never returned to New Zealand. He wrote a large number of books, all marked by extreme originality, humour, and learning and slowly but surely won for himself world-wide fame. The open-air life of the station set him up in health for life and the country in the neighbourhood of his run provided him with the back-ground of his famous book *Erewhon.* He retained throughout life warm memories of his residence here and of the many friends he made, and here and there in his work reminiscences of his experiences in Canterbury crop up, often most unexpectedly.

Butler came to New Zealand with the sole idea of making money and was not the kind of man who could have cheerfully spent his life as a station-owner or sheep-farmer, for his interests were too exclusively intellectual, musical and artistic, scientific and literary. During his residence here he was already making his mark as an exponent of the Darwinian theories, engag-

ing in controversy with the Bishop of Wellington and writing a very notable letter in the *Press* as *Darwin among the Machines.*

It cannot be claimed that Butler did much to advance Natural Science in New Zealand beyond stimulating interest, in the early days of the Colony, in the great new movements in scientific thought. He was acutely observant, but cared little for natural history in general. He found little to admire even among the Alpine flowers of Canterbury, and while he was much interested and intrigued by such things as glaciers and moraines, and the great river-terraces, he made no serious attempt to master the Science which could have interpreted them.

The connection of so remarkable a man with Canterbury, though but short, is very memorable, and it is much to be desired that some permanent memorial of his residence amongst us should be established, if possible, on the site of his old home at Mesopotamia.

A. Wall.

ROBERT BROWN.

As one of the small band of Canterbury naturalists Robert Brown—Brown *ter.* of botanical citation—occupies not only a foremost place, but one truly unique. Ever a poor man, uneducated as judged by ordinary standards, equipped for his self-appointed task most meagerly, he has left an enduring mark on the botany of his adopted country. Nor did he choose an easy path, for he devoted himself to the difficult study of the mosses—so badly-known in his day—and of these, in preference the most minute.

Brown, so far as I have been able to learn, was born in Southern Scotland about the year 1824, but probably earlier. By trade a shoemaker, his life up till he was 52 was spent mostly in Glasgow. At some time or other he studied at the Andersonian University under Professor Hennedy, of whom he always spoke with admiration and affection. Year by year, he made long

excursions on foot into the Highlands investigating the flora. So when he arrived in New Zealand in 1876 he was well-equipped for field studies.

Settling at Christchurch with his wife and family he engaged in business in a small way and bought a house at Merivale. This was his headquarters till the day of his lamented death in December, 1926. There he made a beautiful garden filled with out-of-the-way exotic and indigenous plants.

The first ten years in his new country was principally devoted to a close examination of Banks Peninsula in quest of mosses and ferns. To set forth on foot from Christchurch, ascend Mount Herbert, going by way of Teddington, and return home without resting, was to Brown nothing of moment. Fatigue, insufficient food, no shelter, the fiercest storms were unheeded. His aim was a close search for mosses in all stations and while on the march to steep himself in the beauty of Nature and to observe all living things —animal and vegetable—which he encountered.

On July 7th, 1887, Brown was elected a Member of the Philosophical Institute of Canterbury but though papers had already appeared from his pen (1881-82) it was not until 1891, when at least 67 years of age, that he commenced in earnest to study his moss material. His first paper appeared in 1892 and his last in 1904, in all 21 publications devoted to mosses alone. Virtually the whole of the material was collected by himself, the range of localities being from Taihape (North Island) to the south of Stewart Island and the moss flora of each altitudinal belt being examined.

For the technical part of his work Brown was provided only with an old-fashioned microscope, a camera lucida of his own making, an ancient moss flora of Great Britain, a few specimens of European mosses, and the *Handbook of the New Zealand Flora;* of contemporary literature he had none. Picture this old man of over seventy working day by day, making camera-lucida drawings hour by hour, and at night his table illuminated by a badly-trimmed kerosene lamp.

Or see him in the field facing all kinds of weather, wet through, sleeping in the open and living maybe on a scant diet of oatmeal.

And what did Brown accomplish? This question is clearly answered by Brotherus in *Die Natürlichen Pflanzenfamilien* (1924-25) and from a critical examination of Brown's actual specimens detailed by H. N. Dixon in *Studies in the Bryology of New Zealand.* First of all Brown collected in many localities the flora of which was unknown; e.g. the source of the R. Wilberforce, Te Anau to Milford Sound —he and Morton (the artist) were the first to use the new route discovered by McKinnon long before there was a boat on the lake or other than a blazed track to the fiord—Stewart Island—he walked over the mountains from Patersons Inlet to Port Pegasus—and the Puketeraki Mountains; and further, he added, in better-known areas, locality after locality for different species. Thus he increased enormously the knowledge of moss distribution, and this largely from the ecological aspect also. Secondly he published many valid new species, made cogent, critical remarks about others, and even defined certain new genera or subgenera, dealing with plants of extreme minuteness.

I was personally acquainted with Brown for about twenty years. We travelled much in the wilds together. He was undoubtedly the most enthusiastic naturalist I ever met. From his example and store of knowledge I can say, with pride, that I learnt much. Above all, these words of power are ever in my mind and have guided my studies, "Heed not what books or authority teaches but, in order to really learn, go to the plants themselves." This splendid advice I—now an old man also—pass on to the young naturalists of that Canterbury in which, like Brown, it has been my privilege to work for many years.

L. Cockayne.

Ngaio, Wellington.

December 14th, 1926.

THE ARMSTRONGS

J. F. AND J. B. ARMSTRONG.

The names of the Armstrongs, father and son, must ever be associated with any account of the botany of Canterbury; for by their work, first in collecting, and then in cultivating native plants found chiefly in Canterbury Province, they aroused interest in the cultivation of our native flora. J. F. Armstrong was appointed Curator of the Botanic Gardens, Christchurch in 1867, and held this position for twenty-two years, for the greater part of the time being assisted by his son, J. B. Armstrong. The general plan of the Gardens as they stand to-day was the elder Armstrong's work, but his name is more widely known in connection with the "Old Native Section" of the Gardens, which he planned in 1872 to be a living museum of New Zealand plants. These plants were collected for the most part by the son, who made long and difficult journeys for the purpose into the more remote places of the province, journeys taken in his scanty leisure and for the most part at his own expense. The material thus obtained was not only cultivated in the Gardens, but much of it was sent to botanists and gardeners abroad so that the native section of the Christchurch Gardens became famous all over the world.

Based on material thus collected many important papers were contributed to the *Transactions of the New Zealand Institute* from 1869 to 1881. The most important of these are as follows:—J. F. Armstrong, 1869. *On the Vegetation of the Neighbourhood of Christchurch. Trans. N.Z. Inst.*, II, p. 118. This contains a list of 290 species of plants, many no longer found in the district. J. B. Armstrong, 1879. *A short Sketch of the Flora of the Province of Canterbury with Catalogue of Species. Trans. N.Z. Inst.* XII, p. 325. This paper gives the first comprehensive account of the botany of the district and contains a list of some 750 species of flowering plants and 107 species of ferns. J. B. Armstrong, 1880. *A Synopsis of the New Species of Veronica Linn. with Notes of new Species. Trans. N.Z. Inst.* XIII, p. 344. Concerning this paper Dr. Cockayne stated "Mr. J. B. Armstrong

sprang into the front rank of New Zealand botanists by his bold and excellent paper on the New Zealand Veronicas, in which he foreshadowed De Vries's mutation theory." *Lyttelton Times, June 12, 1911.* It is interesting to note in this paper that Armstrong also considered and rejected the theory of hybridisation as explaining the origin of the different species, a theory now gaining such popularity among a certain section of botanists.

Other papers give descriptions of new species and even of new genera, such as *Corallospartium,* discovered and named by J. B. Armstrong. His original work entitles him to a rank among Canterbury's honoured botanists.

E. M. Herriott.

J. D. ENYS.
1837-1912.

John Davies Gilbert Enys was born in 1837 at Enys, Penryn, Cornwall. He came to New Zealand in 1861 and bought the Castle Hill station in 1864; he also owned for some years a station called Otarama, near Kowhai Bush. At Castle Hill he built the house which he called "Trelissick" and this was his home until 1891 when he sold out and returned home. He entered into possession of the family property at Enys and lived there until his death in 1912. During these last years in Cornwall he was President of the Royal Institute of Cornwall and also of the Royal Cornwall Polytechnic Society. He never married.

Enys was a most enthusiastic, capable and indefatigable field naturalist. He devoted himself especially to the Botany, Geology, and Entomology of his district. He was the first to discover and investigate the vast stores of marine fossils in the Tertiary limestone of the gorge at the junction of the Thomas and Porter Rivers, and many of the types of these fossils were first collected by him.

He made many notable discoveries among the plants of the Craigieburn Range and of Mount Torlesse between which his station was situated. Among these may be mentioned *Ranunculus Enysii, Cardamine* (now *Nasturtium) Enysii, Carmichaelia Enysii, Agropyrum Enysii* (now *A. aristatum*) and *Anisotome Enysii. He* made valuable collections of plants on a visit to the Sounds of the South-west, particularly in Resolution Inlet, and many of his specimens are treasured in the Herbarium of the Canterbury Museum.

He was (in 1883) the discoverer of a curious fern, the moonwort of the Old World, *Botrychium lunaria,* on a spur of Mount Torlesse, and this has never been seen before or since in New Zealand.

He contributed to the *Transactions of the New Zealand Institute,* in 1871, a paper on the nomenclature of Ferns in New Zealand, and published in Christchurch in the year 1880 a *Catalogue of the Butterflies of New Zealand,* with coloured plates and a preface.

A. Wall.

The Early History of Canterbury.

By Johannes C. Andersen, F.N.Z. Inst.,
Librarian, Alex. Turnbull Library, Wellington.

Whilst the 16th December, 1850, when the first pioneer ships arrived in Lyttelton, is the date taken as the first birthday of Canterbury, its history began before that date; and as more and more old diaries come to light the dark years between the coming of the first white man are slowly being pierced by a ray here, a ray there, the earliest prickings of the dawn.

Captain Cook came within sight of Canterbury on the 16th February 1770, at which time he named the Kaikoura peninsula "The Lookers-On." This name was given because four double canoes containing fifty seven Maori (Cook called them Indians), came within a stone's throw of the Ship, and then stopped, the occupants "gazing at us with a look of vacant astonishment." They could not be prevailed on to approach nearer, and presently turned and made for the shore, it being dark before they had made half the distance. At daybreak on the 16th Banks Peninsula was in sight. At eight in the evening it lay to the westward, distant ten or twelve miles, and had the appearance of an island. "At sunrise the next morning, our opinion that the land . . . was an island was confirmed, by our seeing part of the land of Tovy Poenammoo [Te Wai-pounamu, —the South Island] open to the westward." At eight in the morning he sighted an opening at the south end, "which had the appearance of a bay or harbour," distant ten to twelve miles; this was no doubt the harbour of Akaroa. He named this land Banks's Island, and estimated its distance from the mainland of the South Island at about fifteen miles. In this he was no doubt deceived by the low plain-lands which, especially if there were any haze, would have the appearance of water. His description of the peninsula was fairly near the truth:—"It is of a circular figure and about twenty four leagues in compass. It is sufficiently high

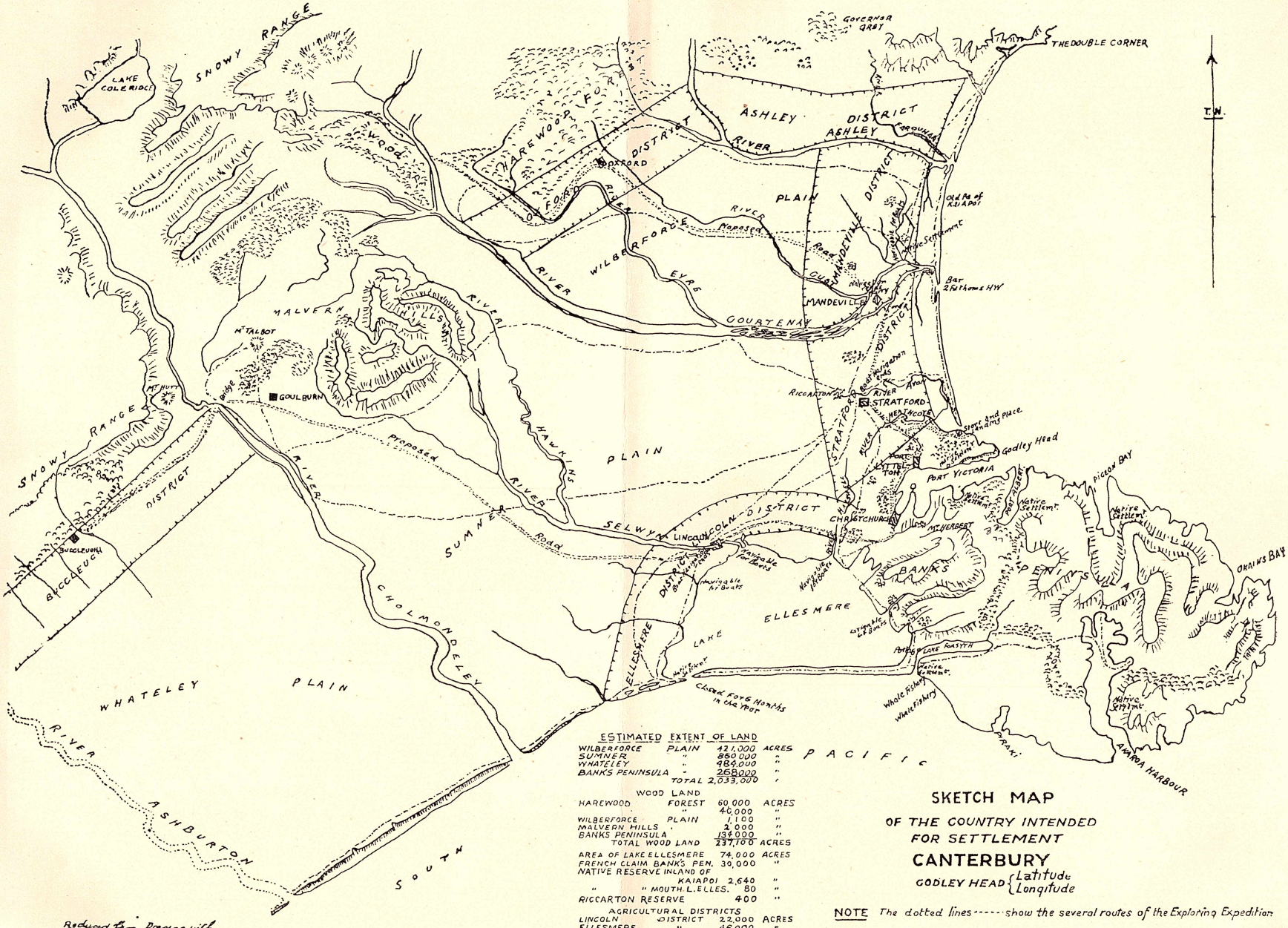
to be seen at a distance of twelve or fifteen leagues, and the land has a broken irregular surface, with the appearance rather of barrenness than of fertility; yet it was inhabited, for we saw smoke in one place, and a few straggling natives in another." The future left no doubt as to its fertility. He speaks no more of any part of Canterbury; he was standing on and off the coast about the Waitaki on the 20th and 21st, and on the 22nd, "at sunset, the weather, which had been hazy, clearing up, we saw a mountain which rose in a high peak, bearing N.W. by N.; and at the same time we saw the land more distinctly than before, ... which, at some distance within the coast, had a lofty and mountainous appearance." It is no doubt vain to conjecture what this high peak may have been. On the 25th Cape Saunders was named; Canterbury was left behind.

Great praise has always been given to Cook for the general accuracy of his chart of New Zealand. He made the South Island rather narrow-waisted, but (if the flippancy will be pardoned) narrow waists were the vogue in his day though they fortunately are not now. He himself explained that as far south as latitude 43° his chart will be found to be pretty accurate, that is, a little south of the Hurunui. Between 43° and 44° 20′ —that is from below the Hurunui to Timaru—he says, "the line may be doubted, for of some parts of the coast which it represents we had scarcely a view. From latitude 44° 20′ to Cape Saunders (45° 50′, the Waitaki is a little north of 45°), our distance would not permit me to be particular, and the weather was besides extremely unfavourable . . . . Tovy Poenammoo is for the most part a mountainous, and to all appearance barren country; and the people whom we saw in Queen Charlotte's Sound, those that came off to us under the snowy mountains, and the fires to the west of Cape Saunders, [and some on "Banks's Island"] were all the inhabitants, and signs of inhabitants, that we discovered upon the whole island . . . . . we are not sure whether the name Tovy Poenammoo comprehends the whole southern island, or only part of it."

His journal, his charts, show Cook to have been a most painstaking, accurate, judicious man. His chart of New Zealand was modified from time to time as later

information was received by the British Admiralty. Banks's Island remained an island for many years. It was found to be a peninsula by Captain Chase of the ship *Pegasus* in 1809. In that year he explored Stewart Island, naming Port Pegasus after his ship on 7th August, and sailing north, on his return attempted to make the passage between Banks's Island and the mainland. He discovered there was no passage, and named the bay to the north Cook's Mistake. The name was later changed to Pegasus Bay after his ship; and on a map published in London in 1832 for the Royal Geographical Society, it is named "Cook's Mistake or Pegasus Bay." W. B. Rhodes claims to have been the first to have actually come to anchor in the bay, which he did on 8th August, 1836, in the *Australian,* anchoring twenty one miles north of Port Cooper (Lyttelton) and twelve to fourteen miles off shore in twenty fathoms. The peninsula is shown joined to the mainland by a very narrow "sandy neck" on Arrowsmith's map of 1841; the full width is given to the connection on his map of 1844, but here Lake Ellesmere, not shown at all on the map of 1841, is shown lying between the rivers Ashburton and Rakaia, though those rivers are not shown. A point about the position where the mouth of the lake ought to be is called "C. Ortegal—nearly the antipodes of C. Ortegal in Spain." Not until the survey of Captain J. L. Stokes in the *Acheron,* March and April, 1849, was the coast-line from Cape Saunders to the Kaikouras brought out to the position it occupies on the present charts and maps.

It was the reports of Cook that opened New Zealand to the sealers, the whalers, the flax-traders; it was his charts that made the navigation safe for them. They were whalers who first landed in Canterbury, but naturally their concern being with the sea they had little to say about the land, and little information about that is to be gleaned from their journals. The first who made anything like a permanent settlement on the coast was Capt. Geo. Hempleman, who came to Port Cooper on 17th February, 1836 in the *Bee.* Here he beached the vessel for repairs and whilst there visited Akaroa and Pigeon Bay by whaleboat for spars, etc. He built a temporary house of timber and flags—the flags being doubtless raupo; the upper part of the har-



ESTIMATED EXTENT OF LAND			
WILBERFORCE	PLAIN	421,000	ACRES
SUMNER	"	880,000	"
WHATELEY	"	484,000	"
BANKS PENINSULA	-	268,000	"
	TOTAL	2,033,000	"

WOOD LAND			
HAREWOOD	FOREST	60,000	ACRES
	"	40,000	"
WILBERFORCE	PLAIN	1,100	"
MALVERN HILLS		2,000	"
BANKS PENINSULA		134,000	"
TOTAL WOOD LAND		237,100	ACRES

AREA OF LAKE ELLESMERE	74,000	ACRES
FRENCH CLAIM BANK'S PEN.	30,000	"
NATIVE RESERVE INLAND OF KAIAPOI	2,640	"
" " MOUTH L. ELLES.	80	"
RICCARTON RESERVE	400	"

AGRICULTURAL DISTRICTS		
LINCOLN DISTRICT	22,000	ACRES
ELLESMERE "	46,000	"
STRATFORD "	64,000	"
MANDEVILLE "	75,000	"
ASHLEY "	62,000	"
OXFORD "	56,000	"
BUCCLEUGH "	75,000	"
TOTAL	400,000	"

SKETCH MAP

OF THE COUNTRY INTENDED FOR SETTLEMENT

CANTERBURY

GODLEY HEAD { Latitude / Longitude

NOTE The dotted lines ------ show the several routes of the Exploring Expedition

SCALE

0 1 2 5 10 15 20 MILES

Reduced from Drawing with Red dep. 149

Johannes Andersen

April 1905

bour was known as Whanga-raupo. Several other ships visited Port Cooper whilst Hempleman was there, and whales were plentiful. He left for Sydney on the 24th July, 1836, returned in September, and shifted all gear to Peraki, on the southern side of Banks Peninsula, making there the first permanent white settlement in Canterbury, in March, 1837.

The two harbours known as Port Cooper and Port Levy were named after the two partners of a Sydney trading firm. They were Cooper and Holt when W. B. Rhodes became connected with them in 1836, and in that year Rhodes in a petition to the New Zealand Land Company, dated 11th June, 1849, claimed certain lands on the Peninsula through having purchased from the Maori occupants. He said he visited the Peninsula in 1836 and again in 1839, and re-established stock and trading stations. It was noted above that Rhodes claimed to have been the first to cast anchor in Pegasus Bay, which he said he had done when in the *Australian* in 1836. When Hempleman left Port Cooper for Sydney in July, 1836, there were seven vessels in the harbour: —the *Sisters*, the *Harriet*, the *Australian*, the *Caroline*, the *Elizabeth*, and two Americans, the *Nile* and the *Friendship*. The *Australian*, Captain Rhodes, had appeared on 16th July.

In the petition above referred to Rhodes claimed, as successors to the defunct firm of Cooper and Holt, formerly Cooper and Levy, that a large part of the Port Cooper district had been purchased from the Maori; but as the port was likely to be of prime importance in view of the proposed settlement on the adjacent plains, he and his brother partner George Rhodes were willing to give up their claim provided they were permitted to retain their principal station at Purau Bay (spelt Puri) together with 500 acres adjacent, an area of about an acre to cover the buildings of their whaling station Oashore (Goashore, now Ohahoa) on the south west side of Banks Peninsula, and that they were placed in the same position as the Canterbury settlers as regards squatting licenses. In the petition it was stated that Capt. Wiseman, the agent of Cooper and Levy, was shipwrecked and drowned at the Peninsula, when all documents regarding the purchase of the district were lost, and all that the Maori participants in

the transaction were dead. Wiseman was, however, wrecked and drowned at Easy Bay, Stewart Island, in a gale, on 28th February, 1831, the ship being the *Industry*. Moreover, Purau was not originally selected by Rhodes, but by the three Greenwood brothers, who located themselves there in 1843, and through certain misfortunes were so disheartened that they sold out to W. B. Rhodes and Co. for £1710 on 25th May, 1847, the purchase including all buildings, stock, etc., on the place. Rhodes certainly had been in occupation of lands, for the whaling station had been worked by him, and cattle had been landed at Takapuneke (Red House Bay) in Akaroa Harbour in 1839, W. Green being left in charge; and Fox, agent of the New Zealand Company, gave favourable consideration to the petition.

By means of the recorded "lives" of Joseph Price, however, we are able to speak of Canterbury prior even to 1835 when Hempleman visited Port Cooper. He was first in New Zealand waters in 1830, being on board the *William Stoveld* when she was recorded as whaling at Kapiti on 25th June, 1830, returning to Sydney on 13th August with 50 tuns of oil and 25 tons of flax. Eight months after his return to Sydney he was in Port Cooper, trading for flax, in the *Victoria*. He and the trading master, Williams, went overland from that harbour to Kaiapoi. They lost their way on the plains, and had some difficulty in finding the mouth of the river, the Waimakariri. The Kaiapoi was not, of course, the town of the present name, but the Maori settlement Kaiapohia, where they got pigs and flax in exchange for powder and muskets, tobacco and blankets. The pigs and flax were sent to Rapaki, thence to the bay, Purau, where the barque lay. Thence they sailed to Akaroa, where more flax was secured.

Price was at Kaiapoi, or rather Kaiapohia, just between the two events that were so disastrous to the Ngai-Tahu, the Maori occupants in possession at the time. In December, 1830, their great, though disliked tohunga Tamai-haranui had been treacherously taken prisoner at Akaroa by Te Rauparaha through the instrumentality of European Captain Stewart of the *Elizabeth*, and about a year later Te Rauparaha laid siege to Kaiapohia itself, putting to death about a

thousand of the inhabitants on its fall, following it up with the massacre of the refugees and other Ngai-Tahu at Onawe in Akaroa Harbour,—a disastrous blow to the Canterbury Maori. He says nothing, however, about the character of the plains he traversed, nothing about the Maori pa which he must have seen; the only information we have is that he was there, and received flax and pigs and Maori hospitality. There is a suggestion that the siege of Kaiapohia was imminent, for he says that after lying in Port Cooper for a week they sailed to a Maori settlement in Otago, probably Waikouaiti, taking as passengers among others a Maori chief Momo, and returning to Port Cooper after two weeks time, taking back with them the chief Momo, who was expecting Te Rauparaha from Kaiapoi.

Thus we know that early in 1831 there was a European in the Canterbury that was to be, four years earlier than Hempleman's first visit to Port Cooper.

These "lives" also give us details of the first actual settlement on the plains. In December, 1839, Price founded a shore whaling station at Ikirangi on the south west side of Banks Peninsula, another station being founded at Ohahoa, a little to the west, next year, 1840, by Paddy Ryan, worked by Price for a time in 1841, and later taken over by Geo. Rhodes. Price whaled till 1852, when he started farming in what was later known as Price's Valley, Little River.

The timber for the buildings at Ikirangi was cut at Little River, and towed down the river and lake to the beach. The mouth of the lake (Forsyth) appears then to have been open to the sea. On 7th April, 1840, there landed at Ohahoa from Sydney Messrs Heriot and McGillivray, Mr and Mrs McKinnon and child (afterwards Mrs Parkinson), Mr and Mrs Shaw, "Whistling Tom," and Ellis. These had been sent by Messrs Blackett and Dodge, millers of Sydney, with a view to their taking up land and starting farming. They brought with them a dray, and eight bullocks, and set out for the plains, taking up their quarters at what was afterwards Riccarton. Once a fortnight they came to Ikirangi for provisions, where they got ten pounds of flour and ten pounds of meat for each man,—flour at that time being £80 a ton in Sydney. About thirty acres were ploughed up, and a good crop resulted, but

it was eaten by Maori rats; and this loss, together with the fear of the Sumner bar, discouraged these pioneers, and they abandoned the place after eight months' occupation, leaving a stack of straw behind them. McKinnon settled on the peninsula later on, and Ellis returned when Christchurch was more than a visionary city, and was partner with Gartner in the Golden Fleece Hotel, opposite Cook and Ross the chemists.

On the 17th August, 1840, the *Comte de Paris* arrived at Akaroa with French and German settlers. It had been intended to found a French colony here, a Captain L'Anglois having made a partial purchase from the Maori owners in 1838. Governor Hobson, however, had had possession of the whole of New Zealand ceded to the British through the Treaty of Waitangi, two months before the arrival of the *Comte de Paris,* and courts were held at Akaroa immediately preceding the arrival; and rather than face another sea voyage after the six months voyage just completed, the settlers elected to remain at Akaroa though under British rule. Town and country lots were laid out, and Akaroa thus became the first town founded in Canterbury. There was thus a market for dairy produce open to the Hays and Deans Brothers when they settled at Pigeon Bay and on the plains.

On 11th February, 1843, in a schooner built by him in Wellington, Captain Sinclair brought the Deans Brothers, John and William, to Lyttelton, they intending to settle on the Port Cooper (Canterbury) Plains, as they were unable to secure their selections at Wellington. In April of the same year he brought the Hays to Pigeon Bay. They like the Deans Brothers had been unable to secure their selections at Wellington. The Hays landed in Wellington from the *Bengal Merchant* on 3rd February, 1840: William Deans arrived in the *Aurora* earlier in that year: he was later joined by John, who arrived in Nelson, by the *Thomas Harrison,* in October, 1842. Captain Francis Sinclair arrived in Wellington by the *Blenheim* in 1841. These selections were made with the approval of the New Zealand Company, from whom the Wellington selections had been made. The Deans Brothers occupied the land that had been temporarily occupied by Heriot and McGilli-

vray, and the land or some part of it has remained in the possession of the family to the present day. They called the spot Riccarton, and named the river towards whose headwaters their selection lay, the Avon, after the Avon near their home in Ayrshire, Scotland. The three brothers Greenwood, James D., Joseph, and Edward, also came from Wellington in Sinclair's schooner, the *Richmond*, in 1843, and settled at Purau Bay; but in August, 1846, they were robbed by three men who had represented themselves as shipwrecked sailors; and shortly afterwards, Joseph Greenwood was drowned while sailing from Purau to Motunau (Captain Sinclair was also drowned earlier in the year on the way to Wellington); and the remaining brothers were so disheartened by the misfortunes that they sold out their interests in Purau to W. B. Rhodes and Co., in May, 1847.

In 1840, Captain Joseph Thomas had arrived in Wellington as a settler by the *Adelaide*. He visited other parts of New Zealand as far south as Dunedin, and returning to England, he was sent out by the New Zealand Company in July, 1848, to select a site for the proposed Canterbury Settlement. Three times there had been a danger that the Canterbury Settlement would be elsewhere than where it is. The Nelson Settlement would have been planted on the Port Cooper Plains had not Governor Hobson insisted on its being nearer the already established Wellington; the Scottish Settlement would have been planted there had not F. Tuckett, reporting on the suitability, fallen foul of the swamps between Ellesmere and Christchurch; he went further south and finally recommended Otago; and thirdly, when the Canterbury Settlement was decided on, those in power, including Sir George Grey, recommended and wished it to be planted on the Ruamahunga Plains, Wairarapa Valley, near Wellington. Captain Thomas, however, recommended the Port Cooper Plains, and a first block of a million acres was selected, extending from Double Corner, at the Waipara, to the Ashburton River, Banks Peninsula lying at the middle of the coast-line. The Peninsula contained four good harbours,—Akaroa, Pigeon Bay, Port Levy, and Port Cooper, the rest of the coast-line contained no harbour at all; and of the four harbours

mentioned only one, Port Cooper, was of any value with reference to the plains adjoining, so that in the matter of harbours nature was liberal to no purpose.

Captain Thomas's report on the plains after his selection of them, dated 15th May, 1849, is of great interest. It is printed in the first issue of the *Canterbury Papers* (1850), where also are printed the fine long report of the Deans Brothers on the plains, dated January 20th, 1849, an extract from a despatch of Captain J. L. Stokes, dated May 1st, 1849, regarding his survey of the coast-line, and other good reports, all well worth reprinting, so good a picture do they give of the plains as they then were. The first issue of the *Canterbury Papers* also contains a map showing the general physical features of the Canterbury block, but the writer long ago saw, and copied, an old dilapidated tracing which showed much more detail. This is of much greater interest than the published map; it shows Christchurch at the head of the harbour, there called Port Victoria; it shows Lyttelton to the west of Rapaki; and where Christchurch was later located it shows a village Stratford. Lincoln is given a local habitation, so is Oxford; but two other inland places, Goulburn and Buccleugh, proved stillborn. The map is reproduced herein. The area of bush or forest on Banks Peninsula was estimated at 134,000 acres; in 1906 it was estimated at 800 acres—over 130,000 acres of bush destroyed in less than fifty years!

(Extracts from Despatch of Mr. Thomas, the Associations Agent and Chief Surveyor, dated May 15th, 1849.)

1. The Port Cooper District having been fixed as the site of the Canterbury Settlement, I have now the honour to report, for the information of the Committee of the Association, upon the country and harbour.

2. The block of land on the east coast of the Middle Island, from which the million of acres for the site of the Canterbury Settlement is to be selected, contains over two million of acres, extending coastwise to the north and south-west, and bounded inland by a range of hills whose distance from the coast varies from forty to fifty miles.

3. The country is perfectly level, watered by numerous rivers and streams, and covered with grass. Like all extensive districts, portions of it are found of inferior quality, a very small part is swampy, indeed so trifling that a dray may be driven over almost every part of it; the surface in some parts is stony, but on examination we found it confined to the surface alone, the soil consisting of a light loam, resting on gravel and a substratum of blue clay; much of it is well adapted for agricultural purposes and capable of yielding excellent crops of all kinds of grain, potatoes and European fruits and vegetables.

4. The whole of this extensive and almost uninhabited tract of plain country affords excellent natural pasturage, and is particularly well adapted for the depasturing of cattle and horses.

5. The produce of a very extensive country, extending along the east coast for 200 or 300 miles, will have Port Cooper as its market and harbour.

6. Banks Peninsula contains no less than four good harbours, viz., Akaroa, Pigeon Bay, Port Levy, and Port Cooper. The country is hilly and well wooded, and the three former harbours are separated from the plain country, except by forming long and expensive hill roads; thus, Port Cooper alone is of any value with reference to the plains adjoining.

7. The harbour of Port Cooper, situated in the N.W. Angle of Banks Peninsula, though open to the eastward, affords good and safe anchorage. Large ships anchor about four miles up, whilst brigs and large schooners lie off the port town of Lyttelton. It has no bar, is easy of access and egress, and has been frequented by whalers of all nations for the last twenty years, and no accident is on record; and with a lighthouse on Godley Head (which I should most strongly recommend) might be entered with safety in the darkest night.

8. The districts Lincoln, Stratford, Mandeville, Ashley, Oxford, and Buccleuch, are for the most part grassy, or partially covered with flax, and can be brought into cultivation at a very moderate expense; and I recommend these districts to be first occupied, not only on account of the quality of the land, but the first three with regard to the relative position of the

harbour, as also of their possessing in many instances the advantage of water communication for the transport of their produce, and supplying them with timber and firewood from Banks Peninsula: and the last two with reference to the large extent of forest land adjoining.

9. We were agreeably surprised to find that mosquitoes, which are common in many parts of New Zealand during the summer season, were seldom found on the plain; and we attributed their absence to the very small extent of swampy land.

10. The best time for colonists to arrive is from October to January; they then arrive in the summer months, have the summer before them to house themselves, and probably form a garden, or break up some land and get in a crop. They should, therefore, sail from England during the months of June, July, and August, and to the middle of September, and I would strongly advise no body of emigrants to leave later than those months.

11. In conclusion, I would offer to the Association my sincere congratulations on its having obtained so excellent a site for its settlement, and one which possesses the advantages considered to be so essential to the future prosperity of the Colony, viz:—A harbour of its own, instead of being dependent upon one appertaining to another settlement, an immense extent of land, easily available for cultivation, removed from danger of disturbance from natives; possessing an extent of grazing country unequalled in New Zealand; and being in every way suitable for being formed into a distinct province with a separate legislature.

Early History of Survey and Exploration.

THE CANTERBURY PROVINCE SELECTION AND EXPLORATION.

By A. Dudley Dobson, M.N.Z.Sc.E., etc.

The Canterbury Association was formed in 1847, and sufficiently advanced in 1848, to take the necessary steps to select a block of land in New Zealand, and prepare the way for intending Colonists. With this end in view, arrangements were made with the New Zealand Company, and a Captain Thomas, who had been one of the New Zealand Company's Surveyors, was appointed agent and manager for the Association. Captain Thomas had been in the employ of the New Zealand Land Company, surveying in what is now known as the Otago District, on the north side of the River Molyneux; he had finished his work, and in 1847 was in London.

Under engagement with the Canterbury Association, he was to select a site for the Settlement, and make necessary arrangements for the reception of the settlers on their arrival.

He accordingly sailed to Wellington, and in November, 1848, arrived at Nelson by the ship *Bernicia,* seeking a site for settlement in Tasman Bay.

He was accompanied by Mr. Cass, and Mr. Torlesse, the former had been second Officer on the Government Brig *Victoria,* and the latter had come from England as a Cadet with the New Zealand Company, and had been engaged surveying in various parts of the North Island.

Captain Thomas examined several suggested sites, and finally decided upon Port Cooper. The site had to be approved by Bishop Selwyn, and the Governor of New Zealand, their permission having been obtained, work was commenced in Lyttelton in 1849.

There appears to have been considerable difference

of opinion respecting the site; the Governor considering either the Rangitiki, or the Manawatu very suitable, and Bishop Selwyn favoured the Wairarapa.

It is very likely that Captain Thomas was influenced in his decision by the opinion of Mr. H. J. Cridland, one of the N.Z. Land Company's surveyors, who had been surveying in the Wellington District; and who in a letter to a friend in London, describing Port Cooper, wrote: " I think it will prove more satisfactory to have it there, than in any other part of New Zealand I have seen, or heard of, from a variety of causes that combine in a peculiar manner, every essential for such an established undertaking.

There are no natives to disturb their occupation or interrupt their progress a single day; there is a splendid Port, free from the slightest danger, perfectly secure, easy of access, and better adapted for commercial purposes than even Port Nicholson, on its nearly opposite shore of Cook Straits. There is deep water in every part of the Harbour, available for wharves, quays, etc., and to crown all, there is an immense tract of level country available, well covered with grass, and watered with abundant streams, embracing an area of forty miles wide, by three or four times as long, within six miles of the Port, easy of access by several routes.

The soil is equal in average with the Hutt as regards quality, free from inundation, or danger, and ready for the plough.

There may be considered an insufficiency of timber, which in New Zealand has been felt rather a drawback in the shape of expense, and clearing. There will be no struggle here to conquer the dense forests, which has so often terminated in disappointment, and which compels the labourer to wait years before he can obtain a sufficient return to remunerate his incessant toil."

This description was decidedly optimistic, nevertheless, the plains offered an ideal situation for easy occupation, far before any other site in New Zealand.

Captain Thomas had for his staff, J. Cass, Cridland, Scroggs, and Jollie; the latter three, had been officers of the New Zealand Land Company, but who had been paid off on the Company getting into financial difficulties in 1845.

Mr. Jollie experienced some rough adventures before he settled down to work with Captain Thomas.

He arrived in Wellington in 1842, and worked for some time in the North Island. On the reduction of the staff in 1845, he joined his brother Francis, who had bought land on the Wakapuaka Road, near Nelson.

In 1846 he tendered for the survey of a block of land on the south side of the Molyneux River, and there he met Captain Thomas, who was engaged in surveying on the north side.

In order to fulfill the conditions of this contract, Mr. Jollie had to engage as survey hands, Nelson men.

He chartered the Brig *Bee,* sailed from Nelson, where he engaged his men and sailed with his partners, Messrs. Wylie, and Wills, to Port Chalmers, where some passengers were landed.

They then sailed for Molyneux Bay, the weather was very rough, and the brig ran to the Bluff for shelter.

On the weather moderating, they sailed again, and in due course arrived at Molyneux Bay, anchored about four miles from the mouth of the river, and although the surf was rather heavy, they all landed safely.

It was here that Jollie first met Captain Thomas, who had chartered a schooner in Wellington, and had landed all the party, with the instruments, but one man, and all the stores were left on the vessel to be landed the next day.

Unfortunately it came on to blow, and the schooner went off to Akaroa, and never came back.

Thomas and his men were living on wild pigs, but Jollie happily enough had an ample store of provisions, and was able to supply him with what he required.

These two parties completed all their work satisfactorily. In order to return to Wellington, all hands went to Dunedin, where they found two small schooners about to sail for the north.

The surveyors Jollie, Wylie, Wills, Gollan, and Pelichet, sailed in one which arrived safely at Wellington in due course, most of the men went in the other, which called at Akaroa, but on leaving that Port was never heard of again.

Jollie returned to Nelson, where he remained until 1848.

Captain Thomas arrived in Nelson in the ship *Bernicia,* where he again met Mr. Jollie, and when had decided upon Port Cooper as the site for the Canterbury settlement, he wrote to Jollie to join him.

Jollie's adventures were not over yet, he took passage in a small cutter known as the *Roaring Gimlet,* sailed from Nelson, on the 12th of July, knocked about in Cook Strait for a couple of days, and meeting a stiff south-wester, ran for Tory Channel, and lost the rudder, by striking on a rock at the entrance.

Geordie Thomas had a whaling station at Terawhiti, generally known as Tarwhite, and his look-out man reporting a vessel in distress, sent his whale boats out, and towed in the cutter, and beached her at his whaling station.

It took three weeks to execute repairs, and the vessel arrived in Lyttelton on August 12th, exactly one month after leaving Nelson. Jollie's adventures give a good idea of the difficulty of getting about New Zealand in those days.

By August, 1849, Captain Thomas with Cass, Torlesse, Scroggs, Cridland, Boys, and Jollie as staff, was busy with the surveys, and Public Works, of the new Canterbury Settlement.

A block of 1000 acres was reserved for the city of Christchurch, main lines of road were laid out north, south, east, and west, and rural sections were set out fronting upon these.

A small amount of land was sold in London on a map prepared for the purpose, but most was sold on land orders, the purchasers to select on arrival.

There being no funds with which to undertake a proper planning and survey of the district, and purchasers being at liberty to select and buy land where they chose, the land was taken up in a very erratic manner.

Sections were selected anywhere irrespective of the position of the other sections, subject only to certain restrictions, as to proportions between frontage and depth.

The sections were numbered consecutively, in order of their purchase, and surveyed where possible in the same order.

Thus section No. 150, 50 acres in area, has on its western boundary, section No. 20720, 20 acres in area, which was purchased many years afterwards.

ORIGINAL SURVEYS.

Captain Thomas commenced a system of minor triangulation in the neighbourhood of Christchurch, rural sections were set out with chain and theodolite, and connected where possible to the trig work, and a great deal of the topographical work was done with chain and compass. He also set out the towns of Lyttelton, Sumner, and Christchurch.

Mr. Jollie did the actual work in setting out Lyttelton, and fixing standard stones in the street lines, which were very useful in subsequent work.

The town of Sumner was afterwards abandoned and the land sold in rural sections.

The plan of Christchurch was prepared by Messrs Scroggs, and Jollie, and approved of by Captain Thomas, after cutting out various crescents, which he declared were unpractical, and mere ginger-bread.

It is evident that these three Surveyors were exceedingly competent men, subsequent surveys made forty or fifty years afterwards, show with what accuracy the work was done, especially when it is remembered that all the original measurements were made with link chains, not with long steel bands, as has been done in later years.

The surveyors must have worked very quickly, for in 1850, Captain Thomas reported that 700,000 acres of land had been triangulated, and 300,000 acres of rural land surveyed for settlement.

It is true that the level, open country of the plains offered an excellent field for rapid work, the only obstructions near Christchurch being swamps, and tall flax in places, through which lines had to be cut before the chain could be used.

The surveys were only a part of Captain Thomas's work. He had the general management of all Public works, the Barracks, a jetty in Lyttelton, and the Bridle path over the hills to Heathcote Valley, also the commencement of the road to Christchurch via Sumner.

Thomas and Cass, expert navigators, made first class surveyors, for a man who by astronomical obser-

vation, and calculation can fix his positions day by day on the trackless ocean, finds little trouble in doing the same thing on dry land, by actual measurement. But it does not appear that the leaders had any engineering experience.

The Sumner road is a case in point, from Lyttelton to the Ferry on the Heathcote River via Sumner was a distance of eight miles; from Lyttelton to Evans Pass, a distance of two miles, and the west shore of the Harbour is mostly rocky cliffs.

Dr. Monro (afterwards Sir David), when reporting upon Port Cooper as a place for settlement for the N.Z. Land Co., said "the shores of Port Cooper are steep banks or rocky cliffs, and to carry a road along the west side, as suggested by Messrs Duppa and Daniel appears to me a work that might be executed by a Napoleon or a King of Egypt, but hardly by the New Zealand Company."

Nevertheless in spite of the very patent obstructions and the great cost of route via Evans Pass, Mr Jollie was instructed to set it out.

Starting at the junction of Oxford and London Streets, Lyttelton, a road was set out at a gradient of about 1 in 20, to Evans Pass, thence round the head of Sumner valley, to the west side, on the same grade, and down that side of the valley to Sumner, where it ended on a cliff 40 feet high.

Through out this length, wherever the earth could be moved by pick and shovel, a narrow track was made, but no rock was touched. This track was so blocked by the untouched rocks, that it could not be used, and people going from Lyttelton to Sumner preferred to take a spur over Mount Pleasant, at the back of the town, climb up nearly to the top of the mountain, and then go down by the spur on which the Golf Links are now situated.

Though the work on the road was never carried on continuously to be of any use, several high stone retaining walls were built in isolated places, which were of no use, until they were incorporated, in the road completed sixty years afterwards.

Had the staff comprised an Engineer, used to mountain roads, a line on fairly easy gradient suitable for wheeled traffic could have been set out from Dampier

Bay, over the Raupaki saddle and down Murray Aynsley spur, which would have entailed hardly any rock cutting, and the plains could have been reached in five miles.

It is not surprising that Mr. Godley expressed much dissatisfaction on his arrival, the funds for public works were overdrawn by £4000, the expenditure on the Sumner road was practically useless, and no transport arrangements had been made for communication between the Port and the plains.

Public works were stopped, the suveyors' salaries reduced, Scroggs had already resigned, Mr. Jollie also resigned. The difference between Mr. Godley and Captain Thomas resulted in Captain Thomas being granted £500, in lieu of further employment.

Meanwhile the remaining surveyors were busily employed under Mr. Cass as Chief, in setting out the land which the settlers were waiting to occupy.

The level and forestless character of the plains, rendered survey work easy, and progress rapid, but it was comfortless work, because there was very little shelter for camps, which in order to obtain water and wood, were established where possible near the rivers.

Light express waggons were much used, enabling the work to be carried on at a distance from the camps, but occasionally the camps had to be pitched between the rivers, and sod-banks built as break-winds for shelter.

On one occasion, the writer was camped near where the Hinds railway station is now.

Thousands of acres of land had been bought between the railway line and the hills, farmers were busy putting up houses, and contract ploughmen, most of whom were living in tents, were busy at work with their teams.

The writer's camp was sheltered behind a high gorse hedge, during the night a very heavy north-west gale started, and blew furiously all night, next morning a number of men came with their drays to collect the remains of the camps, which had been blown away by the gale, and caught in the big hedges. Tents, blankets, clothes, and tin-ware, lined the hedge. A number of sheets of galvanised iron were also in the hedge, having been blown from a stack near a house in course of

erection, five miles off. As the ground was covered with high tussock grass, the wind easily got under the sheets directly they were blown off the stacks, they had been placed on, when unloaded. The hedge was also full of small birds taking shelter, many looking in a dazed condition.

Camping under these conditions was by no means a joy. The winds also seriously interfered with work; in a heavy nor'-wester, no instruments could stand, and sou'-westers were nearly as bad, as light drizzle and mist would then continue sometimes for days. Work in the forests was quite a different matter, on the Peninsula there were no roads, and the country was covered with timber.

The land round the bays was taken up first; access to which was obtained by boats, seamen being well adapted for this class of work, especially if they happened to be good bushmen. Excellent camps were made in the bush, there being plenty of firewood, and water, with the bays to fish and swim in.

It was a life of pleasant adventure for strong young men, and occasionally, amongst the survey hands were found men accustomed to rowing in their college days.

The two Sales, the subsequent Professor and his brother, spent several months, in one of the Peninsula camps; they were great athletes, first-rate oars-men, and made excellent survey hands.

The greater part of the work in forests, is line cutting; sufficient lines have to be cut to enable all boundary pegs to be put in. Lines have to be cut so as to enable angles from the Trig stations to be obtained, this makes surveying in forest country a very lengthy operation compared to the work in level open country.

Some very excellent work was done on the Peninsula, it was very rough travelling round the coast, but subsequent surveys prove that it was very carefully executed.

The roads were not always where they should have been but under the prevailing conditions there was neither time nor money to carefully select the best lines for the roads which would best suit the country as a whole.

Each section as bought had to be set out connected

to a road, (on paper) which the surveyor had to locate to the best of his ability, in the limited time at his disposal.

Sumner Road.

On the election of Mr. Fitzgerald to the office of Superintendent he decided to establish communication between Lyttelton and Christchurch via Evans Pass.

Mr. Edward Dobson, Provincial Engineer, together with Mr. Bray, reported Thomas's line far too expensive a route, and recommended that a short tunnel some fifteen chains in length should be driven under Evans Pass.

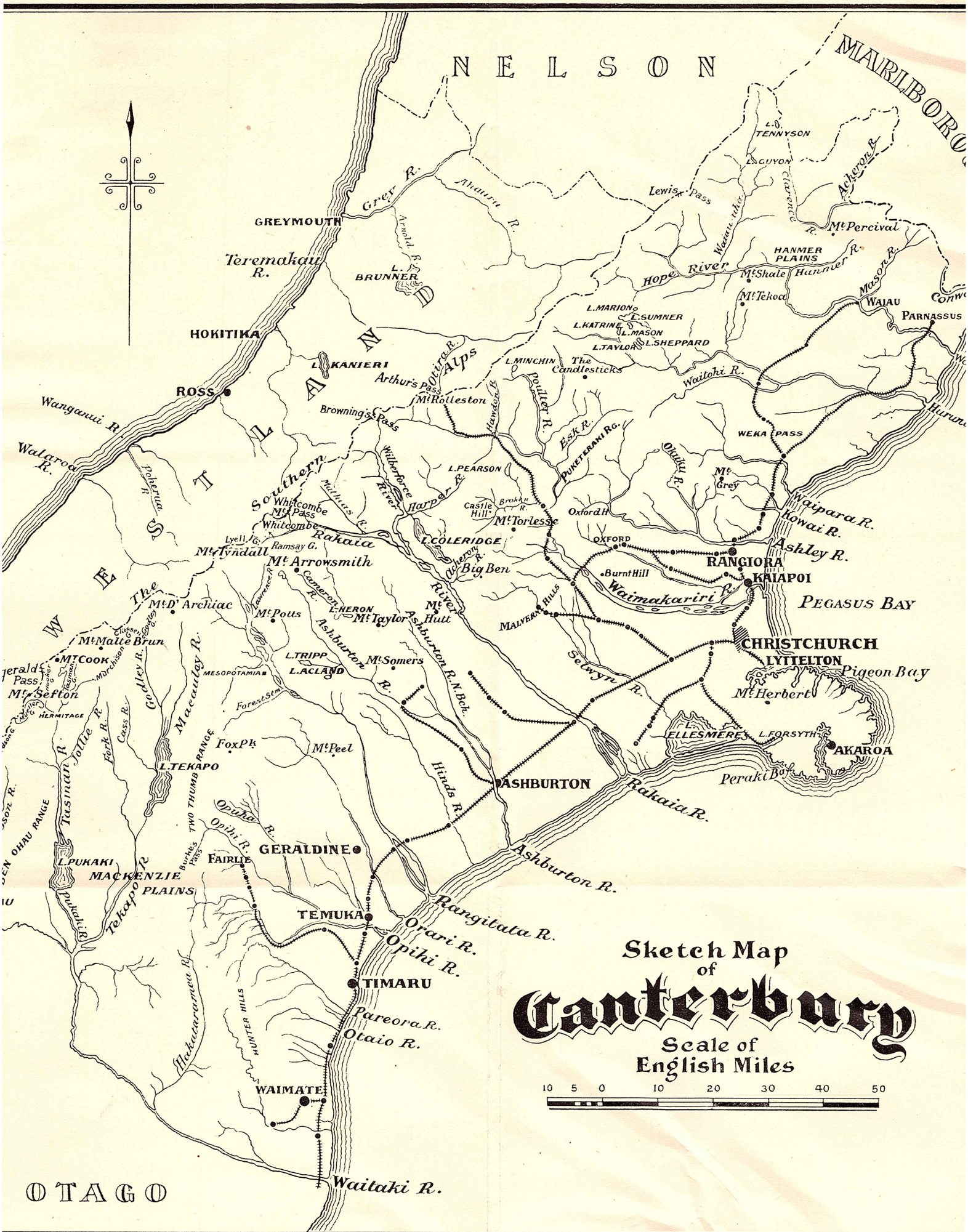
The old line from near Polhill's Bay, was to be abandoned for one on a much flatter grade, that would reach the Lyttelton end of the Tunnel without entailing any heavy rock cutting. On the Sumner side the line was to be entirely abandoned, and a new road made on the east side of the valley, from the proposed Tunnel mouth to Sumner. As a temporary expedient, a steep zig-zag quite workable for wheeled traffic, was made over the pass. This carried all the wheeled traffic until the Lyttelton Tunnel was completed.

As soon as the proposal of the Lyttelton Tunnel was adopted, nothing more was attempted until 1914, when the Government Public Works Department constructed a road from Polhill's Gully, to Evans Pass on Thomas's line. This was a very expensive piece of work, but it provided an excellent road from Polhill's Gully to the top of the Pass. The whole of the line on the west side of the valley has been abandoned.

In the early days no transport arrangements had been made by the authorities for communication between the Port, and the Plains by land, with the exception of a steep bridle track over the hills into Heathcote Valley.

Goods were being taken in open boats over the Sumner bar into the Estuary, but this was dangerous, and accidents happened.

The first attempt to establish a practicable transport by water was made by a Mr. George Day, who owned a schooner, *The Flirt*. He was offered £25 by Mr. Dobson to take a lot of goods to Sumner, Day safely landed the goods, and also examined the channels of the Avon and Heathcote in the Estuary.


NELSON
MARLBOROUGH
WEST COAST
CANTERBURY
OTAGO
Sketch Map
of
Canterbury
Scale of
English Miles
10 5 0 10 20 30 40 50
GREYMOUTH
HOKITIKA
ROSS
GERALDINE
FAIRLIE
TEMUKA
TIMARU
WAIMATE
ASHBURTON
RANGIORA
KAIAPOI
CHRISTCHURCH
LYTTELTON
AKAROA
OXFORD
WEKA PASS
PARNASSUS
WAIAU
HANMER PLAINS
L. BRUNNER
L. KANIERI
L. COLERIDGE
L. TEKAPO
L. PUKAKI
L. ELLESMERE
L. FORSYTH
L. TENNYSON
L. GUYON
L. MARION
L. SUMNER
L. KATRINE
L. MASON
L. TAYLOR
L. SHEPPARD
L. PEARSON
L. HERON
L. TRIPP
L. ACLAND
Mt Cook
Mt Sefton
Mt Tyndall
Mt Arrowsmith
Mt D'Archiac
Mt Malte Brun
Mt Potts
Mt Taylor
Mt Hutt
Mt Somers
Mt Peel
Mt Torlesse
Mt Grey
Mt Percival
Mt Shale
Mt Tekoa
Mt Herbert
Big Ben
Fox Pk
Grey R.
Teremakau R.
Arnold R.
Waiau R.
Lewis Pass
Clarence R.
Acheron R.
Hope River
Waiau-uke
Hanmer R.
Mason R.
Waitohi R.
Alpha R.
Wanganui R.
Waiau R.
Poulter R.
Hawdon R.
Esk R.
Puketeraki Rg.
Oaku R.
Waipara R.
Kowai R.
Ashley R.
Waimakariri R.
Pegasus Bay
Selwyn R.
Pigeon Bay
Peraki Bay
Rakaia R.
Ashburton R.
Hinds R.
Rangitata R.
Orari R.
Opihi R.
Opuha R.
Pareora R.
Otaio R.
Waitaki R.
Tasman R.
Macaulay R.
Godley R.
Cass R.
Fork R.
Jollie R.
Pukaki R.
Tekapo R.
Hakataramea R.
Ohau Range
Two Thumb Range
Hunter Hills
Malvern Hills
Ashburton R.N.Br.
Ashburton R.S.Br.
Harper R.
Wilberforce River
Whitcombe R.
Whitcombe Pass
Rakaia R.
Cameron R.
Lawrence R.
Clyde R.
Shotover R.
Kawarau R.
Matukituki R.
Makarora R.
Waitaki R.
Mesopotamia
Forest Stm.
Hermitage
Murchison G.
Lyell G.
Ramsay G.
Castle Hill
Broken R.
Oxford H.
Burnt Hill
Malvern Hills
Arthur's Pass
Browning's Pass
Otira R.
Alps
Southern
Alps
The Candlesticks
L. Minchin
Pukaki R.
Tekapo R.
Opihi R.
Burkes pass
Fairlie
Mackenzie Plains
Lake Pukaki
Lake Tekapo
Lake Ohau
Lake Wanaka
Lake Hawea
Lake Wakatipu
Lake Wakatipu
Lake Te Anau
Lake Manapouri
Lake Monowai
Lake Hauroko
Lake Poteriteri
Lake Wakatipu
Lake Wakatipu
Lake Wakatipu

The Flirt was the first decked craft that crossed the bar, several other vessels followed, and one at least got up the river, and landed cargo at the "Bricks," the site of the present Barbadoes Street bridge. The fact of some bricks being landed there gave it the name. The Heathcote was a much better river for navigation than the Avon, a good-sized craft could get up to the Heathcote Ferry, and from there be towed up the river, to within two miles of the city, just above the present Radley Bridge.

A wharf was built there known for many years as Christchurch Quay. As trade developed, a mosquito fleet of sailing craft aided by a couple of small steamers, carried all the heavy goods traffic between Port and Plains, until the opening of the Lyttelton Tunnel, after which water carriage rapidly died out.

The Canterbury West Coast.

It would be difficult to imagine a greater contrast, than that which exists between the level grass plains in the East Canterbury Province, and the rugged forest covered country of the west.

Tasman in 1642 described it as a "Great land uplifted high," reminding him of the Island of Formosa and its piles of massive mountains. Captain Cook in 1778, describes it as "an uninhabitable shore of rocks covered with snow, as far as the eye could reach; the prospect was wild, craggy, and desolate."

Had it not been for its mineral wealth, it would probably have been at present, much in the same state as when these navigators saw it.

But even in those days it was known for its mineral wealth, for it was called "Te Wahi Pounamu, the place of the Green Stone," by the Maoris. Tama Ahua, the celebrated navigator's sailing directions for finding the Arahura, was to sail south till Tara Tama was in line with the rising sun, and the mouth of the Arahura could then be entered. Tama Ahua's voyage was probably made in the 15th century.

The Arahura Pah was the principal greenstone market. Tara Tama is a conspicuous peak visible from both sides of the range. Nelson explorers were the first on the Canterbury West Coast. Brunner and Heaphy came down through the Grey country, and

visited the Arahura in 1846, when they found a number of Maoris preparing greenstones for sale.

In 1858 John Rochfort, a Nelson surveyor, who had done much good work exploring and surveying in the Grey, and Buller districts, surveyed the boundary between the Nelson and Canterbury Provinces.

The first survey work undertaken on the Canterbury West Coast was in 1863, when tenders were invited for surveying the coast, and intervening country, from the River Grey to the southern boundary of the Provinces. The work was let in two contracts, the northern length to A. Dudley Dobson, son of the Provincial Engineer, and the remainder to a surveyor who had the misfortune to lose his boat, and some of his hands, on which he abandoned the work without having done work of any importance, but in view of his attempt to do the work, and to recoup his monetary losses, the Canterbury Government made him a compassionate allowance.

Mr. A. Dudley Dobson then chartered a small schooner *The Gipsy* of about 15 tons burden, and on August 8th, 1863, sailed from Nelson with a party of six survey hands, and a crew of four men, a total of eleven on board.

The schooner met very bad weather, but she was a good sea boat and well adapted for the work, several times the schooner rounded Cape Farewell, but was driven back into Tasman Bay, for shelter.

Favourable winds prevailing for a few days a good run south was made, and on September 10th Mt. Cook was in view, and on the 13th an attempt made to take the Grey bar, but the surf was very heavy, and the wind light, and after about an hour's drifting in the surf the schooner piled up on the beach, against the drift timber, with which the upper part of the beach was then covered. Bulwarks gone, back broken, and half full of water, but all hands got safely ashore.

On the shore were a number of Maoris from the Mawhera Pah, and also three white men, Mr. Townsend, Peter Mitchelmore, and John Smith, the party which had been sent to the Grey by the Canterbury Government to establish a relief store, the first named being in charge. With the help of these people, and the tide falling fast, the stores were soon landed, and every-

thing moveable, taken above high-water mark, made secure before dark, and a good camp established in the high scrub.

Gold digging had been going on in the Buller valley, for some time, and prospectors were working their way down the coast.

Maoris from the Grey, who had been mining in the Buller Valley, had returned to the Canterbury coast, and were getting gold in the Ohono a tributary of the Teremakau, several prospectors from the east had crossed the Hurunui saddle, made their way to the coast, and having exhausted their supplies had been assisted by the Mawhera Maoris with enough food to carry them up the coast to the Buller.

It was in order to assist prospectors that the Canterbury Government established a relief store at the Mawhera Pah, as it was then called.

The stores and materials for constructing the necessary building had been landed by the schooner *Wild Wave,* Captain Buxton, May, 1863.

The Government had also sent a party under Mr. Charlton Howitt to blaze a foot-track on the old Maori route over the Hurunui saddle and down to Lake Brunner.

The first news that reached Mr. Dobson's survey party on landing, was that Charlton Howitt, and two of his men had been drowned in Lake Brunner on July 4th, they had gone out from their camp on the lake in a rough canoe, eeling, and never returned, one of the men had remained in camp that night, and next day, as the men did not return, he made a raft with some dry logs, and spent several days polling round the lake, but could find no trace of them, subsequently Howitt's swag was washed up not more than a mile from the camp, on the shore of the lake, but no other trace of them has ever been found.

Howitt had cut a track from the Teremakau to the lake, and was then engaged in blazing a track from the lake over a low saddle into the head of Ohono creek, where the Maoris were digging.

After Howitt's loss, Mr. Drake, a surveyor, was sent by the Government, to complete the track to Ohono, and then to its junction with the Teremakau.

Years afterwards Mr. Drake was drowned in one of the streams between Collingwood and Takaka.

The news of the loss of Mr. Howitt and his men seriously disheartened the men of Dobson's party.

Whitcombe (surveyor), had also been drowned in the Teremakau in April having crossed over a saddle at the head of the Rakaia river, and made his way down to the beach. He was accompanied by Jacob Louper, a Swiss, who though used to mountain work in Europe, was new to work in New Zealand's forests and rivers.

Delayed in the forest by very wet weather, they reached the beach nearly starving, and trying to cross the Teremakau near the sea in two small canoes, lashed together, they were washed out to sea, and Whitcombe was drowned; Louper managed to get ashore.

Dobson's men were set cutting survey lines up the Grey river, whilst he with a half-caste from the Pah, and two Maoris went down the coast to see what the country was like.

Returning in a fortnight's time, he found that Townsend, Mitchelmore, and Solomon a Maori, had been trying to cross the Grey bar in a boat, and had been drowned.

Seven men had now been drowned on the West coast explorations in seven months, and this last misadventure so disheartened Dobson's men, that they decided to leave at once lest they should all be drowned, accordingly they were paid off on October 31st, and went up to Christchurch by the old Maori route which Howitt had opened up.

Dobson then decided that the only chance of getting the work done, was with the help of the Maoris, but to do that, it was necessary to know a little of the language.

With the help of the half-caste, who knew a little English, and a Maori Testament, a start was made to learn Maori, and in about three weeks living with the Maoris, and no one to talk English to, sufficient knowledge of the language was gained to enable the writer to carry on all the conversation necessary for the required work.

Four stout able young men were engaged, who were pleased to have the chance of earning money, and have

plenty of tobacco, at a class of work that they were accustomed to; viz., handling their canoes on the many rivers, swagging stores, and exploring the bush.

They made excellent chainmen, caught birds, and eels, and knew where to find mussels on the beach.

They had canoes on every river, and in addition to the working party, arrangements were made for the older men, to take stores up the various rivers, thus saving the time of the working party.

The work now went on rapidly, the 73 miles were soon finished, the survey of the Grey, and Arnold, to Lake Brunner, and the Teremakau to above the gorge completed.

The Maoris were now getting tired of steady work, and wanted a spell to go to Kaiapoi, to see their relations, and spend their money, for they had been earning very good wages.

As the rivers had now to be surveyed, and swagging stores down the beach to the river mouth, was a tedious matter, it was decided to return to Christchurch, and bring horses over.

A large party of men and women, who wanted to visit their relations in Kaiapoi joined the working party, and the survey was carried up the Teremakau, over the saddle and down to Lake Sumner, to join the existing surveys.

A big canoe capable of carrying about 1½ tons was brought up the river to carry the camp gear, and planted in the bush, just above the junction of the Otira, ready for the return of the party.

On arriving at Christchurch Mr. Cass the Chief Surveyor, was very satisfied with the progress of the work, but was anxious to have the mountains explored to ascertain if any available passes existed between the Waimakariri water-shed, and the west, which would enable a shorter route to be adopted, than via the Hurunui.

With this in view Mr. Dobson proceeded to the upper Waimakariri and found an available pass at the head of a tributary of the Waimakariri, this tributary he named the Bealey.

The Discovery of Arthur's Pass.

The approach to the pass, lying between the Bealey and the Otira, (a tributary of the Teremakau) on the

east side was an easy one, but the head of the Otira was a narrow, rocky gorge, down which it would be impossible to take horses, without a good deal of road making.

This pass was subsequently adopted as the route to the West Coast, when the West Coast road was made in 1865.

By direction of the Provincial Government Mr. George Dobson, one of the Engineers on the Provincial staff, was sent to report upon all the passes through the Range between the Teremakau and the Waimakariri. He reported that Arthur's was by far the most suitable, hence the name.

Mr. A. Dudley Dobson returned to Christchurch, reported the discovery to the Chief Surveyor, bought a couple of horses, engaged four sailors, who had some back-country experience, and returned to the coast, via the Hurunui saddle, getting the horses down through the bush, and the Teremakau river bed to the sea.

The coast Maoris meeting the party with a canoe above the Gorge, down through which the horses were swum, where the water was too deep to be forded.

With the horses for packing the stores down to the coast, and the help of the Maoris with their canoes, at the rivers, the work was finished by October 1st.

This work comprised 73 miles of coast, and a reconnaissive survey of 1500 square miles of the interior.

The survey of the coast from Abut Head to Jackson, which had been abandoned by the contractor, was undertaken by Mr. John Rochfort, who was thoroughly accustomed to that class of work, having done a good deal of rough exploring work on the Nelson West Coast, and the Grey, and Buller rivers.

He arrived at the Grey, in April and completed the work in August.

The West Coast Road.

During the latter months of 1864, numbers of diggers were pouring into the country.

The steamers, *Nelson* and *Wallaby*, were running from Nelson, and many men were arriving overland, from Christchurch, by the Hurunui saddle and Lake Brunner.

In April, 1865, the Provincial Government of Canterbury, decided that the rising importance of the gold-fields, necessitated the construction of a road to join the east and west coasts.

After careful consideration of all practical routes, it decided upon the route over Porter's Pass, through the Upper Waimakariri country to the Cass thence up the right bank of the Waimakariri to opposite the junction of the Bealey, thence up the Bealey over Arthur's Pass into the Otira, and on into the Teremakau, thence down the Teremakau, turning into the bush at the Wainihinihi, and through the bush to the Arahura, thence to the beach and along the beach to Hokitika.

A pack road already existed as far as the Cass, which could be improved into a coach road, at no great expense, it being open country, but from the junction of the Bealey, and Teremakau, the whole of the way was through bush, or river-bed.

The work was put in hand at once, under the charge of Mr. Edward Dobson the Provincial Engineer, who had for his assistants George Dobson, (his eldest son), C. Y. O'Connor, Thornton, Malet, and Edwin Blake.

The work was pushed on with great expedition, and by July, 1866, the road was opened for coach traffic.

The total distance from Christchurch, to Hokitika was 156 miles, from Christchurch to Springfield, there was already forty miles of road, from Springfield to Cass thirty-six miles.

Along this length, all open country, the work consisted in making an existing pack road into one of suitable gradient and width for coaching.

From the Cass to Hokitika, 60 miles, where not river-bed or beach it was mostly heavy work, heavy side cutting, and formation through bush.

Considering the difficulties of the country, and of the work, combined with the continual wet weather, that prevails in the rain forest country, it was a triumph to open a coach road through such country, in fifteen months, and reflected great credit on the management, and all concerned.

From 1866, onwards, was a very busy time for Surveyors and Engineers.

John Rochfort set out the town of Greymouth. The

town of Hokitika was also set out and townships were set out at Marsden, Kumara, Dilmans, Goldsborough, and Stafford, very few now remaining.

There was abundance of work, in setting out roads to the different mining centres, extended claims, mining leases, and water races, in addition to the Government Topographical work.

By 1880, the work had become that of a settled country, and the pioneering days were over.

Surveys and Mapping.

In 1876, the Provincial Governments were dissolved, and the General Government took charge of all Government Surveys, and Public Works.

Mr. Thompson, Chief Surveyor of Otago, was appointed Surveyor General for the Colony. He inaugurated a comprehensive system of surveying, which was adopted throughout New Zealand, and all the work was carried out under his direction.

Hitherto various systems had prevailed, in the different Provinces, but for the most part, surveys were made with theodolite and chain.

Maps were made on large rolls of mounted paper, each roll containing the surveys of a considerable district.

The roads and sections were plotted upon them as surveyed.

The work was built up from the first surveyed sections, but in many cases the sections as sold. did not adjoin, and the connection with the other sections being made by the road lines, in which case a very slight error in the connecting line, would be carried on in the future work.

In some cases where the land was sold in a line of sections up a narrow valley, by the time eight or nine miles were reached the accumulated errors placed the last section far out of their true positions, and in some cases, the sections in adjoining valleys overlapped on the maps, which were really many chains apart on the ground. In other places, the surveys had to be started from independent points.

The really important point was to define the land

purchased on the ground, so that the purchaser could take possession and get to work with as little delay as possible.

For this work Trigonometrical Stations were erected about two, and a half miles apart, and where possible the triangles were carried on so that the work could connect with another Geodesical Station, as a complete check.

The base lines were very carefully measured with standard steel bands, every precaution being taken to ensure accuracy. The angles were observed with 5′ theodolites, the extreme error allowed in the triangulation was 2 links to the mile, and the error in the summation of the angles of a triangle must not exceed 30″.

The position of all the Trig Stations was fixed by latitude, and departure from the initial Station of the district.

By these means in every district, a number of points were accurately fixed, upon which all future surveys could be based, and the work as it progressed thoroughly checked.

In carrying out any survey work, connection to a Trig Station had to be taken as a starting point, and all angles in the work, computed by latitude and departure from the initial station of the district.

Thus in the Canterbury survey district, the initial point is Mount Pleasant.

The advantage of such a system is that even supposing all the boundary marks of a property were destroyed, they could be replaced with great accuracy from the Mount Pleasant Trig Station.

Plans and Office Records.

The old system of plotting the surveys on large rolls was abandoned. The country was divided into Survey Districts, each district to comprise an area of twelve and a half miles square, or thereabouts, and each survey district was divided into sixteen blocks, each three and a half miles square.

This provided a ready means of finding the position of any surveyed section, for example, section 76, one of the original sections sold by the Canterbury Associa-

tion, 700 acres in extent, now part of Christchurch, is described as section 76 Block 15, Christchurch Survey District.

The survey districts, and most of the principal working plans were drawn on sheets 30″ square, and plotted to a scale of 40 chains to an inch.

This made a very convenient size for working upon, and also for storing on the shelves of the map rooms.

The fore-going is merely intended as a brief sketch of the principles upon which the New Zealand Surveys are now conducted; to attempt anything like a full description would occupy far more space than can be afforded for this article.

The Mackenzie Country.

By T. D. Burnett, M.P.

[**Note.** The Mackenzie Country is an intermontane basin, bounded on the west by the main range of the Southern Alps in their highest section with Mounts Cook, Tasman, Sefton, Malte Brun as the dominating peaks, and divided from the rest of Canterbury by the Two Thumb Range and its southerly extension, the Hunters' Hills. The chief rivers from the divide are the Godley, Tasman, and the Dobson, which run through lakes Tekapo, Pukaki, and Ohau, emerge therefrom to take the name of the lakes and junction near the southern margin of the plains forming the river Waitaki. The floor of the basin is fairly flat over large areas, with a height of between 1200 and 2500 feet, and is covered with extensive moraines deposited at a time when the present glaciers were very greatly extended. Rising from the plains and through the moraines are occasional isolated hills and down country of comparatively low elevation. Although geographically a part of Canterbury the Mackenzie Country has characters distinct from the rest of the province and therefore the Editorial Committee has gladly availed itself of the offer of Mr. T. D. Burnett, M.P., a life long resident in the country, to give some account of its natural history, chiefly from the historical standpoint.—Edit.]

The following description of South Canterbury back-country at the dawn of its settlement, and of the immense changes that have occurred in its physical appearance, and of how occupation has changed its fauna and flora, is by a member of a family that settled in the Mount Cook region in 1861, and has been in continuous residence ever since. The notes are written entirely from a layman's point of view, and may be of some interest now, and probably of greater interest as the years roll on, as showing how man has cut right across the path of evolution.

Man has probably from a geological point of view occupied the Canterbury back-country some million years too soon. The gorges are not yet mature, the formation of aggraded valleys, i.e. the rapid raising of the valley floors by morainic material from the huge glaciers at their heads, is still going on. The natural covering of the mountain sides has been destroyed by fire and nothing since has taken its place; and on the plains and dry areas outside the rain-belt, injudicious stocking of sheep and periodic invasions by the rabbit have irretrievably ruined some of the finest indigenous grasses in New Zealand.

I am convinced that in recent geological times the magnificent valleys at the heads of the Tekapo, Pukaki, and Ohau Lakes, were much more beautiful than even they are today. Pukaki Lake extended at least seven miles further up the Tasman Valley; at the then head of the lake beautifully moulded rolling morainic downs left by the retreating Tasman Glacier met from either side through which flowed the Tasman River in a deep well defined channel. The rolling downs on the floor of the valley and the mountain slopes evolved a stunted flora which served the purpose of laying down the first covering of humus on the morainic material that gave it birth. Traces of this old original humus are seen in all excavations made on the north-eastern side of the Tasman Valley; superimposed on it is a covering of from three to five feet of glacial silt-blown clay with twelve inches of black soil and present day humus. As the Tasman Glacier retreated, and became more and more a dying one, its morainic load paradoxically increased, the river brought down enormous quantities of spoil, the surrounding valley downs gradually were smothered;—there are isolated tops of downs still to be seen away out in the valley—and Lake Pukaki rapidly filled up and the process is still going on. As the area of river-bed increased a curious phenomenon developed. The amount of glacial silt to be lifted by the wind increased, and the surrounding valley slopes as time went on became covered with a thick covering, feet deep, of wind-borne glacial silt. The prevailing wind being nor'-west it followed that the valley slopes on the eastern side received a richer endowment than those on the western, that country bordering on the

lakes did not receive anything like its share of this rich soil-building material, and that flats on the eastern and nor'-eastern side of valleys much more rapidly recover from flood damage than flats on portions of the river-bed on the opposite side.

Evidences of the Moa.

The Mackenzie Country and the Waitaki Country generally must have been a favourite feeding ground for the giant moa. It is safe to say that its remains were to be found everywhere, with the possible exception of the country within six miles or so of the present terminus of the Tasman Glacier, the bones and gizzard-stones lying always on the surface among the humus, seldom or never in the glacial silt. Innumerable bones have been found along the lower valley slopes out on the Mackenzie Plains, and, in a rare instance, a handful of gizzard-stones was found at a height of 7,000 feet. One is tempted to think that these huge inland basins were the last strongholds of this remarkable bird, and that from the extraordinary profusion of bones,—and very wide-spread they were in the early days of the settlement—the moa died out from natural causes, probably from a change of climate destroying essential foods and was not killed out by man.

Evidence of Primeval Forest Growth.

When Europeans first traversed South Canterbury in the early 'forties, the only patches of millable bush were at Waimate, Arowhenua, and at Geraldine. Along the whole length of the foothills, however, every sheltered gully contained clumps of native bush mainly broadleaf, with a sprinkling of totara and other pines. It is also told that after the capture and sensational escape of the sheep-stealer Mackenzie, George Rhodes and his manager, Sidebottom, made a traverse of the Mackenzie Country and incidentally took up a block of 'birch' (i.e. beech) bush at Lake Ohau. This latter incident will show how scarce good timber was on the plains. But there is strong evidence of a primeval forest of which the Maori has no tradition. When the first run-holders burnt off the original growth on the South Canterbury downs, a growth that consisted

mainly of cabbage tree, stunted tumatakuri or 'Wild-Irishman' *(Discaria toumatou)* and allied scrubs, they laid bare in many places quantities of totara logs, the remains of what must have been an almost general primeval forest. From what the writer can learn, the remains littered the whole of the downs and extended up the slopes of the frontal ranges on the coastal side. Yet no man has seen this forest, and the Maori, as previously stated, has no tradition of it. When man entered the dry, semi-arid Mackenzie Country, so far as the writer can learn, there was no sign of any early forest, only the creek sides were clothed with an almost impenetrable growth of tumatakuri, tutu, toetoe and blue Spaniard *(Aciphylla Colensoi)* and on the plains well nigh impassable growth of the 'yellow Spaniard' *(Aciphylla squarrosa)* and white tussock. In the central portion of the Mackenzie Country there were no signs of such forest and it was not until one reached the environs of the mountain valleys, and in these valleys themselves, that evidence accumulated of an ancient forest growth. Over much of this country and in present day growth of mountain totara, many logs of large-sized totara have been found. The writer has found slabs of ancient totara at altitudes of 4000 feet on bare tablelands that, since first seen, have been known to grow only mountain spear-grass. It is a debatable point how long this ancient totara would last: the writer is satisfied that provided there were freedom from fire, this wonderful timber would last for centuries on the surface of the ground. He holds the opinion that the ancient totara forests and the moa passed away together. At all events, deep down in the glacial clays of the valley slopes on the western side of the Tasman Valley, charcoal is fairly well diffused.

The interior slopes of the coastal ranges were in 1860 a sheepman's Paradise; Maori cabbage, blue grass, barley grass and even finer grasses were in abundance, while the country was prolific in herbs. No wonder the early runholders thought that the country was not stocked unless the sheep were topping the tussocks. They did not realise that Nature had provided the coarser tussock as a shelter for the finer

grasses. The sheepman learned, but at what a cost!! Today the State and its tenantry have learned—sometimes we have grave doubts whether they have or not learned—their lesson at a cost of seeing the carrying capacity of all that splendid sheep-country reduced by 33 to 40 per cent.

As he left the south-east portion of the Mackenzie Country and continued through the central plains in the direction of the mountain valleys, leaving the drier areas behind, a traveller in those far-off days of seventy years ago, would at once recognise that he was entering the nor'-west rain belt by the change coming over the vegetation. Lake Ohau was fringed on either side with beech forest and its head valleys covered with similar bush. Lake Tekapo was fringed slightly with a belt of tumatakuri but its neighbouring slopes and hills and country at the head were surprisingly bare of anything pertaining to scrub. Lake Pukaki was fringed on the western side by odd clumps of beech and the lake island was heavily timbered with similar trees. On the eastern side at 'Gladstone Chimney,' where the first habitation in the Mackenzie Country was erected, there was such dense tumatakuri in a belt along the lakeside that the sheepman cut and cleared holding yards in the centre of the scrub. In the real nor'-west rain belt of the mountain valleys or gorges, with at times almost sub-tropical conditions for four months of the year—growth of scrub and beech-bush was immense, deluges of rain at high temperature, alternating with periods of intense dry heat and not an enemy in the animal world. In the Tasman Valley the tumatakuri grew to fifteen feet high and in thickness twelve inches. The torokeo *(Corokia Cotoneaster)* that outside the gorges is only a puny, stunted scrub, there grew into trees twenty and twenty two feet in height, with trunks eighteen inches in diameter. The flats and foothills were clothed in impenetrable belts of scrub, consisting mainly of tumatakuri, torokeo, ribbonwood, and the veronicas *(Hebe sp.)*. The waste of riverbed was probably fifty per cent less than it is at present, owing to the river-banks having been better held by the scrub, while the enormous waste from the mountain-sides, since such a marked characteristic of

the Canterbury Alps was practically non-existent below the bush-line owing to the vegetation being left undisturbed.

The beech forest on the western side of the valley was much more conspicuous than it is at present, coming down out of the side-gorges on to the foothills and morainic downs, but never on the shingle fans of the tributary streams, no matter how ancient their formation. On the eastern side of the valley the beech forest, with a few exceptions at the foot of Parson's Waterfall, was non-existent. Its absence, and the reasons therefor, is a mystery to the writer. The burning of the mountain valleys began as early as 1859. It continued all through the 'sixties and early 'seventies; by 1875 it was about complete, and nothing will convince the writer to the contrary but that it was the poor, naked, mountain sides in 1873, which were the chief factor in causing the historic and disastrous flood of that year. The great flood of 1868 was not an Alpine flood, it was due to a warm, February, easterly wind, heavily surcharged with moisture impinging on the coastal ranges. The September 1878 flood had its origin in entirely different causes. A big fall of snow in the Alps, the high basins and table-lands full of snow, incessant rain from the nor'-west for a full fortnight, the natural covering, Nature's sponge, of the mountain side newly destroyed; result,—the greatest Alpine flood from the dawn of settlement to the present time. It made a great difference in the appearance of the mountain valleys; it tore and rent the hillsides by huge slips and scars, it swept away thousands of acres of well grassed river-flats. It may be noted here that it takes approximately forty years for a flood-destroyed flat to re-clothe itself. First the river-bed moss appears, it catches the nor'-wester-borne river-bed silt then the native broom and tussock, then the tumatakuri (Wild Irishman) appears. Afterwards the yellow Spaniard and the finer grasses to which can be added the imported white clover.

In 1859, at Simon's Pass Station was made the first attempt at sowing English grasses in the back country. It was not a success. From that time on persistent attempts have been made to surface sow with English grasses, but with only varying degrees of success.

Generally speaking the most success has been attained in the nor'-west rain area and where heavy scrub had grown originally, along creek sides and round sheep camps. Cocksfoot and white clover and crested dogstail stand out as being the most successful. The dry areas of the Mackenzie basin, the central and south-east portions, have withstood the invasion of the foreign grasses much more successfully than the valleys where the deeper humus has readily lent itself to the inroad of fog grass, couch, clover, and cocksfoot. Fog grass spread amazingly fast through the valleys in the 'eighties, sorrel through the dry areas. One of the problems of the future is the hold that couch will have in the damp, spongy portions of the mountain valleys; it is going to kill out all the native grasses even the most virile of the tussock family.

Taking the broadest view possible, it is the writer's opinion that there are no grasses superior to or even equal to our own native grasses for their particular environment and that on the whole, sheep prefer the native grasses to the imported ones.

Bird Life in the Back Country.

Generally speaking where you found the bush and the scrub densest, there was the bird-life most numerous and the richest in variety. These conditions, so far as the Mackenzie Country is concerned, attained their highest degree in the mountain valleys.

Kea. The first case of sheep killing by keas on Mount Cook Station was in 1868. They were exceedingly numerous all through the Alpine valleys, mobs of thirty and forty being quite common, were fairly numerous along the Two Thumb and other coastal ranges, but were rarely seen in the agricultural coast lands. In April, 1895, three were seen and two shot at Cave by the writer's father. Cave is about twenty miles inland from Timaru.

The kea had his favourite killing grounds; some sheep stations had an unenviable record for kea losses, while other properties alongside have had comparatively a clean bill from losses these sixty years. The losses from kea worrying have been heavier than most people are prepared to admit. On

Mount Cook Station for a period of thirteen years from about 1877 to 1890, the time when the pest was at its worst, the kea losses were conservatively estimated to be from 8 to 10 per cent. Add to this snow losses and natural losses, and then can one wonder that high country sheepmen have smitten the kea on every occasion?

Weka. Round the old station homestead in the valleys in the 'sixties and 'seventies the wekas were as numerous and as tame as domesticated fowls. They were among the most interesting of birds, and the young New Zealander of today will never realise what he has lost of a silent summer evening without the 'woodhen's' call. The white man's love of sport and its associations was too much for it. The rabbiter and his dogs, the rabbit poison and traps, the loss of his beloved natural cover, and the stoat and ferret, all made the fight too one-sided, so it decided to join its ancestors in Moaland. It is extinct in the Mackenzie Country, the last one seen by the writer was up the Godley in March, 1916. Yet in April-May, 1894, a party of Temuka natives, among them a Ngatimamoe named Hare Koteoro killed hundreds in the Tasman Valley on the Braemar country. The birds were dried, salted, and taken down country for the winter store.

Native Quail. Extinct, it died out prior to the rabbit invasion. Its environment was destroyed by the burning of the rank native growth from the plains. It consequently fell an easy prey to the sparrow-hawk. The writer's father tells him that the hawks would deliberately follow a man so as to be ready to swoop down if he flushed a quail.

Sparrow Hawk. These fine birds are slowly but surely diminishing in numbers, thanks to the stoat's attention to its eggs. A most interesting bird, and one admired by even the most callous back-countryman for its 'cheek' and audacity. It is doomed.

Kaka. In the early days its habitat extended from the Alps to the sea. In the 'sixties it was numerous at the Levels Station, being very fond of the flower honey of the flax growing in the gullies near by. Today so far as the back-country is concerned it is gone.

Harrier or Big Hawk. This is about the only

bird that has adjusted itself to changed environment and maintains its old time numbers. Whether you burn out its original swamp home or not, whether you poison rabbits with phosphorous or strychnine it somehow survives. It seems to understand the mechanism of a trap almost as well as a man, and appears to have an uncanny instinct of knowing what is good for it and what is bad. Good luck to it anyway!! On the day that it becomes extinct, the times comes appreciably nearer when the deadly blow-fly menace settles on New Zealand.

Native Pigeon. This bird was at one time fairly numerous in the beech forests of the Lake Ohau country and Glentanner. It is still seen, but in diminished numbers.

Pukeko. At the beginning of settlement it swarmed in the swamps at the head of the lakes. There are still a fair number about, but its days so far as the Mackenzie Country is concerned are numbered.

River-Bed Life. Gulls, sea-martins, stilts, redbills, and shags appear to have held their own better than the purely bush or hill birds. Whether it is that their breeding grounds are not so subject to the inroads of stoats and ferrets or not, I cannot say, but it is remarkable the number of black-backed sea-gulls that apparently fly in from the coast every evening to camp on the river-beds of the interior. I remember one calm winter evening riding through the Mackenzie Pass and in the space of an hour counting no less than two hundred and forty sea-gulls all winging their way inland, and the same flight I have consistently noted for years.

The little sea-martin is beloved of the real back-countryman as a harbinger of spring; many's the glad shout the writer has heard from someone running into the homestead house during the first week in August,—"The sea-martins are back, the sea-martins are back." The redbills come back about mid-September; then indeed we know that the winter is behind us.

The Paradise Duck, Grey Duck, Teal and Mountain Blue-duck. These were in prolific numbers in the early days of the settlement. The writer's father tells him

that he would never bother to fire unless he was sure of getting three or four ducks at a shot. In the 'eighties I have seen a bullock-driver ride up the Jollie Gorge of an evening and come back with his horse all hung round with blue-ducks. The latter is now extinct as far as the Tasman Valley is concerned, the teal is rarely, if ever, seen, and for ten paradise or grey ducks that were seen sixty years ago, probably only one is seen today. The paradise and the grey ducks have become in the writer's opinion more migratory than they were formerly and if all the Alpine valleys were made strict sanctuaries for all the native birds with the exception of the kea, one would never fear the extinction of the paradise or grey ducks, and thus at the same time a fair amount of sport would be provided in the front country.

Chronological order of events bearing on and bringing about the vast physical changes that have come over our Alpine country since Settlement days.

1855. March. Capture of Mackenzie the sheep-stealer.
1856. First cattle and horses introduced by McHutcheson, Sinclair, and Gladstone on Mary's Range.
1857-8. First mobs of sheep arrived.
1859. First attempts at English Grass sowing by John Hayhurst at Simon's Pass Station.
1861. First Rabbit seen in Cave district.
1864 or 5. Seed of sweet-briar introduced "in order to improve the appearance of the lonely station homesteads."
1864. First wire fence in the Mackenzie Country erected between Grampians and Gray's Hills Stations.
1868. Broom and Gorse first planted.
1868. Keas first known to have worried sheep on Mount Cook Station.
1868. Great coastal flood of South Canterbury.
1878. Rabbit invasion first became acute. Regular rabbiters first employed at Haldon Station.
1878. Great Alpine flood.
1880. Systematic large scale farming operations first started in the Mackenzie Country at Braemar Station.

1888. Rabbits first seen at head of the pastoral portion of the Tasman Valley.
1891. Ox-eyed Daisy first appeared in the Tasman Valley.
1896. Hares first became noticeable in the Alpine Valleys.
1903. Hares at their maximum numbers; they have since seriously declined in numbers for no apparent reason.
1924. First Red-deer shot on Mt. Cook Station.

Chronological Order of Historic Snow-storms in the Mackenzie Country.

July, 1861; April to September, 1870, continuous falls; 1879; September, 24th, 1884; July 24th, 1888; June-July, 1895; June 11th, 1903; July 6th, 1908.

Geology and Physiography.

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Historical Introduction.

The two dominating personalities in the history of geological investigation in Canterbury are Haast and Hutton. The former stood practically alone in the two decades from 1860 to 1880 and the latter occupied a similar position from 1880 to 1900. Haast's work was almost entirely of the pioneer type, while Hutton brought to the study of the geological problems a wide range of scientific equipment and above all a training in zoology, which was eminently useful to him in his work on the fossils occurring in critical localities.

Haast commenced his geological investigations in the year 1860, when he was appointed Provincial Geologist, a post he held till the abolition of the provinces in 1876. After that, as Professor of Geology at Canterbury College and Director of the Canterbury Museum, he virtually filled the position and acted as geological adviser to the district till the time of his death, although officers of the Government Survey took over the practical control of the work of examination and report.

The first investigation he undertook was a survey of Mount Pleasant in connection with the proposed Lyttelton Tunnel, but his first striking work as Provincial Geologist was in the direction of exploration rather than a strict geological investigation. Although the search for pastoral land and the desire for opening up communication with the west coast of the island had stimulated the exploration of the river valleys, and notable work had been done in this direction by Messrs J. B. Acland, L. Harper and T. H. Potts, and large areas had been taken up under pastoral leases, as for example that of the Upper Rangitata by Samuel Butler, little was known of the higher reaches of the valleys near the main divide. During the years from 1861 to

1866 Haast made several notable journeys to this region. In 1861 he explored the Upper Rangitata and Ashburton, in 1862 the head of the Waitaki including the Mount Cook District and the head of the Godley, in 1862-3 the country at the head of Lake Wanaka, making on this occasion the discovery of Haast Pass, the lowest crossing of the main divide. In 1865 he explored the West Coast region going south through the then primeval and trackless bush as far as the Franz Josef Glacier, examining on his way over the range the head waters of the Hurunui. In 1866 he visited the head waters of the Rakaia following in the footsteps of Whitcombe and Louper, and traversing the country first viewed from the Arrowsmith ridge by Samuel Butler and Thomas Baker the surveyor. In 1867 he explored the head of the Waimakariri, this river valley having finally been selected as the route to the West Coast, now of importance owing to the development of the gold-fields.

While carrying on this work he examined areas nearer home, specially the Malvern Hills, whose coal seams promised to supply the requisite fuel for an area somewhat deficient in wood.

These explorations attracted much notice in Europe and papers by Haast appeared in various British geological and geographical journals, as well as in several German publications. Attention was thus drawn to an area of great scenic and scientific interest, notably on account of its well developed glacier systems, at a time when controversy as to the existence or not of former glacier extensions was raging in Europe and America. Haast brought additional evidence of the existence of a Pleistocene glaciation much more intense than that obtaining at present from a region far removed from that where the controversy arose, and thus materially aided the advocates of what was then a revolutionary principle in geology.

The landscape features studied during these years of exploratory work impressed him profoundly and it is surprising how accurately he interpreted them even judging by the modern standard of investigation and the presentation of results. His explanations are generally correct, and they are free from the jargon which sometimes mars present day accounts of the

origin of such landscape features and renders them unintelligible to ordinary readers. One word now universally accepted in geological literature, viz., "fan" was first used by him. In his accounts of the features of our valleys resulting from glaciation he showed true appreciation of the importance of ice erosion and of fluvio-glacial deposition, and was in some ways in advance of his time in his sound appreciation of the problems involved.

His account of the formation of the Canterbury Plains contains a masterly summary of the principles governing the movement and the deposition of gravel by rivers and on their application to river control. His work in this direction is still authoritative and suggestions emanating from him are being considered even now when the proper management of rivers has become a question of vital importance to the community.

His experiences in the mountain region of the province gave him a general insight into its structure and most of his conclusions have been endorsed by modern workers. One district, however, viz. that of Banks Peninsula attracted his special attention. His interpretation of its features as recorded in his various geological papers shows a striking evolutionary development. Many tentative hypotheses were abandoned and sounder ones advanced till his latest pronouncements as embodied in his book on the *Geology of Canterbury and Westland,* are not very different from the ideas held at present—forty years after his death.

He also achieved notable results in his study of the Cretaceous and Tertiary beds of the Province with their fossils. The Waipara River, Weka Pass, Castle Hill, Mount Somers and various localities in South Canterbury were his hunting grounds, and most of his collection, including numerous types, are in the Canterbury Museum. He made a collection of marine saurians from the beds of the Waipara River, Boby's Creek, and at Cheviot, which remedies to some extent the loss of the great collection of bones made in the Waipara district by Mr. Cockburn Hood and despatched by him for description and report to Sir Richard Owen, then the foremost vertebrate palaeontologist of the day. These were lost when the ship *Matoaka* disappeared at sea in the year 1868.

The discovery of large quantities of moa-bones at Glenmark and the gift of these to the Museum, led to important work in the classification of the group and the determination of new species. The foundation of this work was laid by Owen, but several new forms accepted in scientific literature were discovered and named by Haast.

This brief abstract of his geological work, indicates the fullness of the years he spent in the province, and the importance of his influence on geological investigation.

The place in Canterbury Geology vacated by Haast was taken by Hutton. His experience as a member of the staff of the Geological Survey and his study of many fossil forms while in Dunedin had given him an appreciation of the importance of the detailed investigation of certain localities within the province almost classic even in his day. His geological work consists mainly of the critical study of such areas as the Weka Pass, the Waipara River, Castle Hill, and the Waihao, with lists of fossils belonging to the various horizons and correlations based on them. His papers were generally polemic in tone and devoted chiefly to the destructive criticism of opinions held by opponents, and to the maintaining of his own standpoint, but he advanced our knowledge materially. He devoted much attention to the petrological description of rocks from widely separated localities throughout the province—many of the specimens examined having been collected by Haast. The general accuracy of his conclusions is remakable considering that this department of geological investigation was then in its infancy, and the slides he worked with were crude in the extreme. He also discussed such subjects as the origin of the Canterbury Plains and the origin of the lœss, holding opinions which were contrary to those held by Haast, and it might be said contrary to those of most subsequent investigators. His descriptions of the Tertiary Mollusca and later on his classification of the moas, based on the extensive collections in the Canterbury Museum, were most important contributions to Palaeontology, but perhaps his article on the *Origin of the Fauna and Flora of New Zealand*, published in the *Annals and Magazine of Natural History* (1884)

attracted most attention seeing that he applied to the problem of the distribution of plants and animals his accumulated knowledge of the geological history of the country. In this he drew extensively on illustrations furnished by the geology of the province. It must be remembered now when the various groups of animals he dealt with are being handled afresh by specialists, and the geological sections he described are being examined intensively, and one is apt to disagree with his conclusions, that his work was that of a pioneer with all the faults of too rapid conclusion and sweeping generalisation, but he was a pioneer of wide sympathies and high intellectual qualities and he has left a record in the geological history of the province which can never be effaced.

In the later '70's and early '80's a considerable amount of investigation was carried on by S. Herbert Cox, a member of the staff of the Geological Survey, and, after he terminated his connection with New Zealand, Professor of Geology at University College, London. He was one of the soundest men connected with geological investigation in New Zealand, and it is unfortunate that his stay in the country was so short. His chief work within the province was connected with the field survey of Mount Somers and Malvern Hills districts, and specially that aspect connected with the deposits of coal, etc., which promised to be of economic importance.

Apart from these three great pioneers there is a fairly long roll of names of those who followed in their footsteps. Among these the following may be specially mentioned:—Alexander McKay, for many years Government Geologist, the greatest natural geologist of New Zealand, who by his own unaided efforts and with a minimum equipment in the way of education has left a reputation for untiring energy and sound common sense which will last as long as the science lasts; T. N. Brodrick, who surveyed the glaciers of the Mount Cook region; Dr. P. Marshall, who was specially concerned with the Tertiary Stratigraphy; Dr. J. Allan Thomson of the Dominion Museum, who described in detail the Weka Pass region and gave a thorough account of its brachiopod fauna; Henry Suter, who did excellent pioneer work carrying forward Hutton's

results a stage further and leaving them in such a state that they were ready for the detailed work of such modern specialists as Dr. J. Marwick and Mr. H. J. Finlay. The present author has also written many papers dealing with various aspects of the geology of the province.

This gives a brief summary of the direction in which investigations proceeded and it remains now to state the general results of those investigations and to furnish an account of the geological history of the provincial area.

GEOLOGICAL HISTORY.

The geological history of the area is twofold. There is first of all the purely geological which traces out the mode of formation and the intrinsic nature of the rocks composing the mountains, hills and plains, and there is that which is more interesting and more readily understood, viz., the sequence of events and the processes by means of which the landscape features were formed out of these rocks, that is, the geomorphology of the area, the latter being dependent largely on the former for its results.

The geological history may be dealt with under the following heads:—

1. *The Southern Alps, their foundation and early history.*
2. *Coal Measures, Limestone, and beds associated with them.*
3. *The Southern Alps, last phase.*
4. *The Volcanoes of Canterbury.*

1. The Southern Alps, their foundation and early history.

The oldest rocks of the Province are those which form the main mass of the Southern Alps, lying in a belt about 40 miles in width parallel with the main divide, together with a few isolated occurrences well to the east. No granites or rocks of similar type, no true schists are contained among them, but they consist chiefly of greywacke—a hard siliceous material, very tough and resistant, grey in colour, formed chiefly out of those minerals constituting granite,—quartz, mica, felspar,—the detritus from a granite land. Not all of

these rocks are resistant. Some, specially those with a high content of felspar, decay very fast and furnish as a consequence serious difficulties in the way of locating stable foundations for our railways and roads along sidelings exposed to water soakage. It cannot be certain where lay the old granite land which provided the material, but it probably stretched away east and south-east from New Zealand and lies now buried under the waters of the Pacific. It may have stretched to the west and disappeared when the movements occurred which resulted in the raising of the Alps as a mountain chain. It is not likely that it lay far away, for pebbles of granite are found over a wide area in the beds forming the mountains, e.g. in the Pudding Stone Valley, in the North Ashburton, near Lake Coleridge, west of Hanmer and near Ethelton on the Hurunui. These pebble beds may, however, belong to a later date and may not be a part of the oldest rocks in the Alps. There is an occurrence of metamorphic rocks, sub-schistose in character, that is, rocks whose crystalline character has resulted largely from pressure, lying near the crest of the range, and also in areas more to the east, e.g. near Fairlie and near Kakahu. They are best developed near Mount Cook in the valley of the Mueller Glacier, and on the eastern side of the Sealy Range.

No doubt when these beds were being laid down on the sea floor in close proximity to the granite land, the crust was slowly sagging down and the thickness of the accumulated sediments must be measured in thousands of feet. The time taken for this deposition no doubt amounted to millions of years. The beds are remarkably free from fossils, Mount Potts on the Upper Rangitata being the only locality where a fauna of any special note has been discovered, reptilian bones and numerous shells occurring in one of the gullies facing the Clyde River on the north-west side of the mountain. A few shells have also been found in scattered localities, e.g. at Arthur's Pass, in the Hawdon Valley, at the upper Waimakariri Cutting, and north-west from Mount Thomas, but only an annelid or worm tube, known as the Mount Torlesse Annelid—is widely distributed. Plant fossils are, however, fairly common and indicate that the water in which the beds

were laid down was somewhat shallow and close to a shore-line. The most important localities for these are Tank Gully on Mount Potts, Haast's Gully in the Clent Hills, Cairn Range and Flagpole Hill—the last two in the Malvern Hills; specimens from these localities have been submitted to well known experts in Europe, who assign the beds in which they occur to the upper Triassic age. These determinations as well as those of the shell-remains fix the geological age of the beds out of which the Alps were constructed.

At the end of the period of deposition great earth-movements took place in the area, and as the result of enormous tectonic forces the vast thickness of sediments was compressed, folded, and raised into a great range of the Alpine type, perhaps even as high as the European Alps. The movement did not take place as the result of one effort but was continued through a long period of time, probably with intervals when submergence of the land and deposition again took place over the area. The folding was not so acute as that shown in some mountain ranges and the structure is not so involved, and if fossils occurred freely, or if there had been any great difference in the nature of the beds laid down at different times during the period of deposition, the detailed structure of the range could easily have been made out, but in the absence of these criteria the true structure still remains one of the puzzles of New Zealand Geology. It should be emphasized here that the range so formed is not that now existing, and that the area has experienced numerous vicissitudes before the appearance of the Alps as we see them now.

It must not be supposed either that volcanic action was absent during the period of deposition of the sediments, for submarine volcanoes contributed the lava flows and ash-beds which occur interstratified with the greywackes, and at the close of the period of sedimentation, probably while the mountains were being raised, volcanoes broke out on the flanks of the range, and built up a great chain of cones, stretching from the Rangitata to the Selwyn, whose remnants now form the Gawler Downs, the Clent Hills, Mounts Somers and Alford, the Rockwood Hills, including High Peak, Pullwool Peak and Mount Misery. These volcanoes

poured out lava of two kinds:—(1) rhyolite, a white or pinkish rock, occasionally green, and almost universally containing small red garnets, and (2) a dark grey rock called andesite. The precise order of these is still uncertain, but probably the rhyolite is the older of the two.

These volcanoes were no doubt connected in some way with the movements which resulted in the formation of the mountain chain, the ridging up of the sediments causing belts of weakness in the crust parallel to the chain and furnishing a ready outlet for the molten rock lying below its flanks.

When this range first appeared above the surface of the sea the forces of subaerial denudation at once commenced operations, and as it rose they acted more effectively, so that there were agencies in operation counterbalancing the forces of elevation, which in the long period of time that was available neutralised the elevatory movement. As a result the range was reduced to a fairly level surface—a peneplain—so that by the latter part of the Cretaceous period only an isolated mass or two of resistant rocks had escaped destruction, and a large part of the area stood at a comparatively slight elevation above sea-level. It is possible that more definite remnants of the range existed to the westward, over the tract now known as Westland or even further west still under the waters of the Tasman Sea, but the Canterbury area had been reduced so that it presented little relief and was ready by the end of the Cretaceous Period for the deposit of the next great series of sediments.

2. Coal Measures, Limestones, etc.

The second definite stage in the geological history of Canterbury commenced with the laying down of a series of beds with seams of coal at its base and limestones forming important members of its higher horizons. When the mountain range of the Mesozoic era was reduced to a peneplain towards the end of the Cretaceous period, estuarine and shallow water conditions obtained over fairly wide areas, and woody material—consisting of stems, leaves, seeds, and spores,—was swept from the higher ground down

towards the sea margin where it accumulated as seams of coal. And as the land sank following on its reduction in level by erosive agencies, the area favourable to coal accumulation extended over the reduced mountain area, so that while coal measures usually occur near the base of the series in every locality, it must not be inferred that all the coal was laid down synchronously. It is probable, too, that the lowering of the level of the land did not take place evenly, but that some areas maintained their height while neighbouring tracts sagged slowly down, and probably after a time the areas which stood up sagged down in turn, but everywhere as the conditions for the accumulation of the coal became favourable, seams were formed.

Elevations or islands must have stood above the peneplained surface during the period of deposition, since the plants must have had a home all through where they could flourish as the neighbouring areas sank. In all probability their refuges took the form of low islands standing above the peneplain, but the areas where plants could flourish grew more and more restricted as time went on and deep water covered the expanses where formerly shallow water existed.

It must not be assumed either that the land lay to the westward, as one might think, judging by its present elevation. The mountain area did not exist at that time, and the land may have lain to the east, since the nature of the sediments associated with the coal is indicative of the presence of wide-spread areas of rhyolite—far larger than those existing now—which furnished at times gravels of practically pure rhyolite or containing only a small admixture of rocks like those occurring to the west. This rhyolite land may have occupied the present site of the plains and have been depressed and covered up at a later date.

The evidence of the widespread occurrence of coal measures is furnished by the numerous patches which occur over the present mountain area. There are larger occurrences, such as those at Castle Hill, Broken River, in the valley of the Esk and at High Peak, but every valley has its small remnant, once part of a covering sheet, now detached and isolated. These may be tabulated as follows:—

In the Hurunui Valley,—at the Mandamus, near Kaiwarra, and on Mt. Alexander.

Waipara Valley,—at Heathstock and north-west of Mount Grey.

Ashley Valley,—the small patch in Lees Valley.

Waimakariri Valley,—in addition to those already mentioned, patches in Sloven's Creek, on Noman's Land, near Lake Pearson, and at Benmore.

Rakaia Valley,—at Redcliff Gully, at the Acheron, at the Harper River, near Lake Heron in the Smite, and at the Gorge of the Cameron and on Teddy's Hill.

Ashburton Valley,—near the Stour, up Chapman's Creek, and near Clent Hills Station.

Rangitata Valley—at Coal Creek, at Potts River.

Waitaki Valley,—near Richmond Station, near Lilybank Station, on Balmoral, west of the Tasman, etc.

Similar patches also occur in the upper Pareora and Otaio, and near Fairlie. This enumeration indicates how widespread are the occurrences. Their height above sea level is at times remarkable. Coal seams occur on Lilybank north of Lake Tekapo at a height of nearly 5000 feet, and on Teddy's Hill near the Cameron River at a height of 4700 feet,—two occurrences which clearly indicate the changes in level of the land since the coal measures were laid down.

The largest existing area of coal measures lies along the base of the mountains, and to it belong the Malvern Hills, Mount Somers, Kakahu, Waihao, and other detached patches of what was once a continuous strip. The gravels of the plains cover up certain intermediate sections and thus the continuity is not clear. It is possible, too, that there was a break somewhere between the Rakaia and Ashburton Rivers and the measures belong to two distinct areas, continuous in themselves but never permanently united, and the southern area of later date.

The beds associated with the coal are sands and clays;—the latter at times approaching a fire-clay in refractory properties. Some of the sands are practically pure quartz and may be used some day in the manufacture of high grade glass, but generally they are stained with oxide of iron and therefore fit only for bottle glass or glass of similar grade. These clays and sands probably represent the main mineral wealth of the province.

The coal seams are generally lens-shaped, and thin out or pass into stone when traced in either direction along the strike. They have not been followed down far to the dip, since they generally become poorer in that direction as well, and no prospecting, either by shafts or by bores, has been carried out in order to determine if the quality or quantity improves again when followed further. In almost all cases the coal is of the brown variety, and frequently contains much water and ash. Only in close proximity to volcanic intrusions does the quality really improve and then there are occurrences of excellent coal, that is, altered brown coals, and mineral cokes—as at Brockley, Steventon, Springfield, and at the Acheron. Unfortunately these areas of improved coal are of limited extent.

The total quantity of coal mined in the Malvern area since 1860 is in the vicinity of eight hundred thousand tons, so that the total amount yielded by the coal fields of the Province does not much exceed one million tons. It is not likely that the amount available, and still in the ground, exceeds that already won.

The sands in the higher levels of the coal measures are frequently characterised by the presence of concretions, that is, rounded masses cemented by calcium carbonate. Occasionally they are up to 7 feet in diameter, and with them are associated various fossils. These are usually molluscs, such as oysters, *Conchothyra, Trigonia, Inoceramus, Belemnites,* etc., the oysters sometimes occurring in thick massive beds. In places there are saurian bones as well, which include Ichthyosaurs, Plesiosaurs and Pythonomorphs, some of them of large size, up to 25 feet in length. The most noted localities for these are the Waipara River, its tributary called Boby's Creek, Cheviot, Castle Hill, and

the Malvern Hills, but the Waipara area has been up to the present the most prolific. A large collection was unfortunately lost when the *Matoaka* disappeared at sea, but no doubt many remains still exist undiscovered, for every few years fresh finds are reported. These reptiles appear to have been entirely marine or estuarine in their habitat, and no discoveries have been made of flying reptiles or of those huge herbivorous or carnivorous beasts (Dinosaurs) which walked the land of the Northern Hemisphere during Jurassic or Cretaceous times. Still their remains may yet be found.

Succeeding the concretionary sands in the North Canterbury area are usually greensands, which pass up into marls and limestones. These are best developed in the country running north-east from Mount Grey, across the Waipara River to Weka Pass and on again in the direction of the Hurunui. Another strip follows the coastal range from the mouth of the Waipara near Teviotdale through the Limestone Range, past Mount Vulcan to the vicinity of Port Robinson, to re-appear again at the mouth of the Conway, at Amuri Bluff and at Kaikoura, and further on still to the north. The limestone is usually white in colour, and fairly pure calcium carbonate in its lower portions, which are known as the Amuri Limestone, but it is capped by a limestone of poorer quality, well developed in the Weka Pass and called for that reason the Weka Pass Stone. The Amuri Limestone will ultimately be used extensively as a source of agricultural and builder's lime, as well as for crushed limestone. In the northern part of the area, as at Kaikoura, it contains a good deal of flint, but this is wanting in the Waipara area. An outlying patch occurs near View Hill in the Oxford District, where it has the consistency of chalk, and like the English Chalk is rich in flints. In other parts of North Canterbury, as at Castle Hill, the typical Amuri Limestone is wanting, and its place is taken by marls.

Wherever the Amuri Limestone is found it is poor in fossil shells, but rich in the low forms of marine life which have contributed so largely to its composition. The purity of the stone and the presence of these forms indicate that it was laid down in deep water, probably in a sea at least 100 fathoms deep, and perhaps 200, so

that fairly deep water existed over the North Canterbury area in those times, and the existence of similar beds at Castle Hill indicates that the sea extended over the mountain region. The sequence of beds indicates a gradually deepening sea, after the coal had been deposited, and that its depth reached a maximum during the time of the deposition of the Amuri Limestone, and that a period of shallowing commenced with the deposition of the Weka Pass stone.

This is further marked by the increased amount of detrital matter contained in the succeeding deposits. A marl, greyish in colour lies over the Weka Pass Stone, which passes up into the sandy beds and then into a rubbly impure limestone, called the Mount Brown Stone since it is typically developed at Mount Brown on the Waipara River. Two layers of this stone are fairly pure limestone and they are very rich in brachiopods or lamp shells whose peculiar features enable the beds to be correlated with the Oamaru Limestone and Awamoan horizon of North Otago. The Mount Brown Stone merges into pebbly beds with shell remains, and the sequence finally closes in the typical area with gravel beds containing fragmentary shells. The thickness of the series from the basal coal measures in the Waipara district to the top of the gravels amounts to some 5000 feet.

In Middle and South Canterbury there is a similar series passing up from coal beds to limestones and shelly pebble beds, but the comparison with beds of similar lithographical character in the northern area is not exact, and the periods when the conditions favoured a particular facies did not exactly tally. In general the South Canterbury beds belong to a later date than those of North Canterbury. The sequence developed is best seen in the Mount Somers, Kakahu, and the Waihao districts. In all of these we have clays and sands with coal resting on greywackes, the coal being invariably of the brown variety and as a rule of poorer quality than that at Malvern. This is succeeded by clays and sands, some of them of good commercial quality, such as those at Mount Somers and Kakahu. Then follow limestones, which are never as pure as the Amuri stone, and then pebbly beds with shells, as at Waihao, the Pareora, and Otaio.

The course of marine sedimentation indicated above continued both in North and South Canterbury almost to the end of the Tertiary era but there is evidence that towards its close important changes in the height of the land commenced. This is clearly indicated by the presence of great thickness of greywacke gravels—older than the gravels of the Canterbury Plains—which occur in places along the foot-hills, and also in the intermontane basins, such as Castle Hill and the Mackenzie Country. They are well developed on the Mount Grey Downs, near Amberley, in the Okuku, on the Mairaki Downs, and in various places in South Canterbury. In some localities the beds are over 1000 feet thick. They probably continue under the visible gravels of the plains, since an older set of gravels, brown in colour, and more thoroughly cemented appears in places, as at Rakaia Gorge, where the newer gravels have been deeply incised by recent rivers. The presence of these older gravels is the first indication of the approaching rise of the land over the western area of the province which culminated in the creation of the Southern Alps in their present form.

Another point should be briefly referred to here. Towards the middle and latter part of the Tertiary era, at the time of deposition of the limestones and afterwards, volcanoes broke out in numerous places. They probably commenced as submarine eruptions, for ash beds are found interstratified with the sedimentary deposits. In addition to these are lava flows and intrusions or dykes. The Banks Peninsula volcanoes belong here, and volcanic action was wide-spread, for traces of its action are found near Timaru, at Geraldine, at Mount Somers, at Malvern, at Burnt Hill, near Oxford, at Glentui, and then after a considerable break at Culverden, Hanmer, and at Waiau. They are also found inland at Castle Hill, the Esk River, and at Sloven's Creek. The whole question of volcanic succession in the Province will be considered later.

3. The Southern Alps.—Last Phase.

Perhaps the most interesting geological movement is that which commenced at the close of the Tertiary Era and resulted in the formation of the Alpine region of the province as it now appears. The last phase of

mountain building commenced as a mere uplift, with a minimum of deformation, by which the peneplain worn down in Cretaceous times with its covering veneer of coal measures, limestones, etc., was raised bodily to a height approximating to that which it has now. There was some deformation, however, for the elevatory movement was attended with faulting, and the sinking down of certain areas, and these events could not happen without some slight adjustment of the neighbouring blocks of country. The elevation took place slowly and was not brought about at one effort, the period of time involved no doubt amounting to millions of years.

The fault lines produced at this time are generally arranged in two groups, (1) one running N.E.-S.W. and responsible for many of the valleys trending in that direction, such as the Waikari, Omihi, Greta, Lees, and that of the Upper Selwyn, and (2) one running N.-S. or N.W.-S.E. which perhaps accounts for the directions of the valleys of the main rivers as well as some subordinate valleys associated with them. The areas which sagged down or were faulted down, are Castle Hill, the Upper Waimakariri Basin, the Mackenzie Country, the Hanmer Plain, and the Culverden Plain, and the formation of these is no doubt connected in some way with the fault movements. In the valleys and basins so formed occur detached patches of the covering beds, sheltered from active erosive agents by their low elevations and by the mountains which ring the areas, while the cover has been worn off the heights in between, except in one or two places where remnants still existing at high levels mark by their presence the amount of the elevatory movement and also indicate how wide-spread was the former cover.

The directions of the main valleys were determined initially by these dislocation lines, but they were modified, and added to, by streams developed normally on the slopes as they arose. In some cases, too, streams originally existing, before the rise reached its maximum had their directions changed by the dislocations cutting across the line of their already established courses. This suggests that some of the dislocatory movements are of fairly recent date, and there is some evidence, specially from the earthquakes associated

with these lines of fault that the movements have not yet ceased. So that definite modification of the land surface owing to deep-seated earth movements is still going on and making changes which in process of time may be of considerable magnitude.

There is no doubt that considerable changes both in the forms of the valleys and in the directions of flow of the streams were caused by a severe glaciation which the area experienced as the mountains reached a height at which snow could accumulate and glaciers form. There was a period of maximum glaciation during the Pleistocene, and possibly during the time when the intensity was high, there were minor oscillations, perhaps even periods when the glaciers almost disappeared, and that after the last maximum the ice has gradually retreated till the glaciers of the present day, considerable though they are, are mere remnants of the former ice covering. At the height of the ice-flood all the main mountain valleys were filled with ice, probably to a depth of 3000 feet or even more, judging from the height on the valley walls where glacial scouring occurs. All the side valleys, too, were occupied but the thickness was not as a rule as great. The higher levels were completely mantled with ice, with a few solitary rocks sticking through the covering sheet. This was no doubt more complete towards the west, but the higher levels on the eastern facing of the range still had their small glaciers, and from all the main valleys glaciers deployed their fronts on to the plains. This is clear from the heaps of morainic material at the mouths of all the gorges. Thus the Waimakariri Glacier reached down nearly to Springfield, and may have reached to Sheffield. The Rakaia touched the line of the Hororata River to the north and came nearly to Methven on the south. The Ashburton reached to the township of Mount Somers, the Rangitata came almost to Peel Forest, and the Mount Cook group covered wide areas of the Mackenzie Country.

The cause of this glaciation is still uncertain. Captain Hutton thought it was due to the increased height of the mountains; von Haast thought it was due to the mountains being more plateau-like in those days and as a consequence capable of holding more snow. Hutton's idea is generally supported, but there

is a feeling that the extensions of the glaciers may be due to climatic changes after all, though the arguments advanced by Hutton are on the surface incontrovertible. He has shown that there cannot have been any great refrigeration of the climate or its effect would be apparent on the plants and animals, specially on their distribution, and no effect is visible. But when it is considered that a similar glaciation affected all countries round the South Pole at about the same time, elevation of the land appears a doubtful cause, and probably the extension of the glaciers is due to some influence world-wide in its incidence.

The chief modifications of the valleys by glacier action have been straightening and widening by sapping back the walls and by cutting off the spurs that naturally project into a stream valley; overdeepening, and the formation of lake basins by erosion of the floor; the deposit of moraine and angular debris sometimes as definite barriers across the valley and at other times as a deposit over wide areas, e.g. near the Lake Coleridge Power House, over the Upper Ashburton Plains and in the Mackenzie Country at the outlet of Lakes Tekapo, Pukaki, and Ohau; the change in the direction of drainage by the blocking of certain valleys with moraine and the reduction of divides as the ice streams passed over them, such as the diversion of the Cameron from the Ashburton to the Rakaia, and the diversion of the Upper Selwyn from the Rakaia to its present course through the Selwyn Gorge. There has been as well a general dissection of the upland so that a feature of the area is the occurrence of many isolated peaks or groups of peaks, which are being continually reduced in height and area and more definitely cut off from their neighbours as erosion proceeds. Naturally this process is more intense towards the west where there is more ice and as a consequence neighbouring valleys in that region are often divided by knife-edge ridges while further east the divides are broader and often plateau-like in form. Frost as distinct from ice still exerts a most potent influence. The rocks have been deeply jointed as the result of earth movements, water penetrates down the crevices and freezes in winter, and, as it exerts enormous force under such circumstances, disruption proceeds apace.

Wide areas are covered with moving debris, which gradually works to lower levels, clogs the floors of the valleys and streams issuing from them. A part is carried forward to the sea margin of the land and adds to the coastal strip where it is protected from the wash of ocean currents, and the action of powerful waves.

In bygone days, while the glaciers were at their maximum this process went on at a more rapid rate and it resulted in the formation of the Canterbury Plains, which are the fans of deposit formed of the streams issuing from the fronts of the glaciers. These plains are such a distinctive feature of the land surface of the province, the source of its chief wealth, and the real reason for its being a settlement and a home for men that special chapters are being devoted to their origin, form, and surface covering.

4. History of Volcanic Action.

It will be convenient as a conclusion to this account to summarise briefly the history of volcanic action in Canterbury. The earliest volcanic phase occurred during the deposition of the greywacke, at which time ash-beds were laid down on a line stretching from near High Peak towards Flagpole Hill in the Malvern area, and on across the Selwyn Gorge to the vicinity of Dalethorpe. A similar line occurs in the Ashley Gorge extending north-east through the Blowhard Range to the vicinity of Mount Thomas, and no doubt other lines occur in the remoter parts of the mountain area. But no really great volcanoes occurred at this stage.

A great epoch of volcanic action commenced at the close of the period of mountain building before the coal measures were laid down. These were the palmy days of volcanic activity when the outbursts rivalled in magnificence those which have produced the great volcanic cones of the North Island. Brief reference has been made to this above. Mount Somers probably marked the site of the greatest cone, but a long line of vents stretched south-west and north-east from this and outpourings of similar material occurred at Gebbies Pass and at the head of Lyttelton Harbour, and there is a probability that other occurrences now buried up under the gravels of the plains linked up the Gebbies Pass and the Mount Somers extrusions.

These were succeeded by andesites on the western end of the Rockwood Range, at Rakaia Gorge, at the Gawler Downs and at the Clent Hills, though the last two occurrences may ultimately be assigned to an earlier date. Taken together, these outpourings, though great in volume, were not as wide-spread as those which began in the Middle Tertiary and continued till the end of the era. All along the base of the mountains—which did not then exist in their present form, there were eruptions of basalt. The remnants of the lavas frequently occur capping the downs as at Timaru and Geraldine, where they have furnished a protective covering for the underlying gravels or sands. The same condition occurs at the Harper's Hills, at Burnt Hill, on Chalk Hill, on View Hill, and on Starvation Hill near Oxford. Ash is frequently included in the limestones as at Mount Somers where volcanic action immediately preceded or was partly contemporaneous with their deposition, and where a peculiar basic glass called palagonite has been erupted, forming the isolated twin hills known as the Brothers. At Castle Hill, too, beds of ash are found separating the limestones, indicating that limestone formation and volcanic action were contemporaneous in this area as well. Similar conditions occurred at Burnt Hill before it received its capping of basalt, near Waiau and at the Mason River and on the Whale's Back on the Waiau-Kaikoura Road. Some of these ash beds are noted for the richness of their fossil content;—for, as the ash fell over the sea, it destroyed the animals inhabiting it, and entombed and preserved their remains so that the ash-beds yield a surprising number of fossil forms and thus give a clear epitome of the marine life in those areas during Mid-Tertiary times.

A remarkable feature too is the large number of intrusions which penetrate the associated beds. Fissures must have formed freely in all directions and liquid rock been injected from below, both as vertical walls called dykes, or as more or less horizontal sheets called sills. The former are particularly common in the Malvern Hills where coal has been frequently changed by their agency, and the same area furnishes excellent examples of sills, such as the great sill at the Acheron, that in Rakaia Gorge on the south bank of the river

near the Mount Hutt Homestead, and those near Steventon and Glentunnel. These great intrusions may have been connected in some way with the faults and rifts formed as the Alps were finally raised towards the close of the Tertiary Era, the fissures providing an easy upward path for the intrusions of molten matter from below.

By far the greatest existing mass of volcanic rock is that forming Banks Peninsula. The earliest eruptions of this area were rhyolites, but the great bulk of the peninsula was built up from lavas poured out from two centres,—Lyttelton and Akaroa. Round both vents great volcanic mountains, approaching Egmont and Ruapehu in volume and height, were constructed out of basaltic and andesitic flows and fragmentary material. No doubt the material poured out from each dovetailed on the common boundary so that it is at times hard to say from which of the two centres some of the lavas came. Both cones have well developed systems of dykes radiating from their centres.

During the process of building and after action had ceased, they were subjected for long periods to erosive agents; the craters on their summits were enlarged by explosions and subsequently by water action, radiating valleys were cut deeply into their outer surface, another vent opened near Mount Herbert, and the lava flows from it form the long gentle slope that stretches from the summit down to sea-level at Diamond Harbour. This last eruption cannot have taken place so long ago, geologically speaking, since the streams on this gentle slope have not incised their valleys to any depth, except where they reach the margin of the sea. From the Mount Herbert period of activity dates also the small cone in the middle of the harbour, called Quail Island, in fact the lava flows exposed on its northern face may actually have come from Mount Herbert. In all probability it marks the last dying flicker of volcanic activity within the provincial area. All through this period, erosion of the main mass of the peninsula was proceeding apace, especially as the land stood at a higher level, and then the land sank, the sea invaded the craters, and occupied the lower reaches of the valleys forming the two great harbours and also the

fringe of beautiful bays which borders the complex of rugged hills now known as the peninsula.

LANDSCAPE FEATURES.

No account of the geological features of the mountain region of the province would be complete without some reference to its chief scenic attractions, viz., mountain, glacier, lake and river. The origin of the mountains has been dealt with above but their striking landscape characters are referred to briefly here. While the summits in general have an average elevation of about 7000 feet, approximately the height of the snow-line, they become increasingly higher towards the west, where the culminating peaks are distributed. However, the highest points do not lie on the main divide, but on spurs leading from it. Thus Mount Cook (12,349 feet) and Maltebrun (10,421 feet) lie on spurs of the main range, D'Archiac (9,279) lies near the junction of the Two Thumb Range with it, and Arrowsmith (9,171 feet) lies 15 miles to the east of Tyndall (8282 feet) on the main divide. This probably indicates that still higher elevations once existed towards the west, which were reduced in level owing to the more active erosion on the western flanks of the range. The snowfall was here heavier, the glaciers larger and more powerful, and the heavy westerly rains were extremely active transporting agents, so that the main crest has been lowered and the products of erosion removed, leaving the highest points now standing to the east of it.

Near the eastern margin of the mountain area the ridges are fairly broad, usually covered with loose debris, and the adjacent slopes are masked with surplus material, forming the characteristic shingle slips of the Canterbury mountains and ever slowly moving downwards and clogging the gullies and valleys. But removal after all does not keep pace with formation and there is a tendency to accumulation. Further west the condition is reversed, the broad ridges become knife-edges and rock-waste is swept away as soon as formed, exposing ever fresh surfaces of rock to erosive agents, where they are not protected by the plant covering. Thus the migration of the highest summits towards the east is continued.

The similarity in the form of many of these peaks is due to the fact that they are constructed of similar rocks, inclined at approximately the same angle, and as they are thus exposed to similar influences the form of the peaks approximates to a general type. Before the positions of the chief summits were definitely fixed by accurate survey, numerous mistakes in identity occurred. Thus Haast named three peaks Mount Tyndall, the first as seen from the Rangitata Valley, the next from the Godley, and a third from the Rakaia. He thought they were all the same, but the mountains are entirely different, and the present Tyndall of the Survey, as fixed by observations from the West Coast, is after all none of the peaks named so by Haast.

All along the main divide the mountains are ice clad, the covering being more complete where the range is higher. Here the excess of ice reaches down to the valleys so that their upper reaches are characterised by glaciers of the first order. In the Waimakariri Valley the glaciers are small, and in the Hurunui which lies further north there are none at all, but in the neighbourhood of Mount Cook lies the Tasman Glacier which is approximately 17 miles in length, 3 in breadth, covers an area of 22 square miles, and reaches down to its terminal face at a height of 2456 feet above sea-level. This glacier receives numerous tributaries, while to the east lies the Murchison Glacier, with its terminal face up a side valley, so that it does not now junction with the Tasman although it must have done so formerly. The Hooker and Mueller are glaciers worthy of special notice on the eastern side of the range in the Mt. Cook district, while on the west are the Franz Josef, the Fox, and the Landsborough. At the head of the Godley River are the Godley Glacier, and the Classen; at the head of the Rangitata, the Forbes, Havelock, Frances, and Lawrence; while at the head of the Rakaia are the Lyell, and Ramsay, and on the south-eastern face of Mt. Arrowsmith the Cameron and Ashburton. At the head of the Hopkins and Dobson draining into Lake Ohau there are small glaciers, notably in the former river, where the Foster and Richardson Glaciers are situated. There are many others of smaller size, tucked away in hollows of the mountains at the head

of tributaries of the main rivers, but they are hardly worthy of special mention.

A special feature of these glaciers is the enormous amount of moraine that they carry. In their lower reaches the ice does not show at all except at the terminal face, so complete is the covering. This consists of blocks of all sizes, up to those as large as a cottage. The amount of debris is partly due to the extreme susceptibility of the rocks of the ridges flanking the glaciers to the action of frost and partly due to the slow rate of travel of some of the glaciers which allows time for debris to accumulate,—the Tasman moves at a rate of between 12 and 18 inches a day and the Mueller an average of less than 7 inches a day. In their higher levels they are comparatively free from debris and their beauty is unmarred. Many beautiful ice-falls feed these glaciers and notable among them may be mentioned the Hochstetter Ice-fall, the great ice face of Sefton and the Forbes Ice-fall as seen from the shoulder of D'Archiac. On the western side of the Alps there are also many beautiful falls, but they are in the valleys of the Franz Josef, Fox, and Landsborough, beyond the scope of this work.

As mentioned previously our glaciers show a recent rapid recession of the terminal face, specially is this the case with the Mueller, Hooker and Cameron, but recent observations show that the Tasman is now advancing and the retreat of the face of those mentioned, may not really indicate a present marked decline in ice action, but may be part of a periodic change which has various maxima and minima. It may not be out of place to mention that the Franz Josef is now showing marked signed of advance.

In these glaciers rise the chief rivers of the mountain area, wild torrents at the beginning, liable to sudden rise from north-west rains and melting snows especially in the spring-time. Walled in by precipitous ice-scoured slopes in their higher reaches, they afterwards occupy wider valleys with broad flat floors formed of shingle, covered by water only in flood-time, and at other times only partially occupied by braided streams, till they lose themselves temporarily in lakes or enter on the plains by deeply incised gorges. All the main streams possess these features. In some cases

lakes do not now exist but all the evidence points to such having existed at one time, the erosion of the barrier at the lower end, combined with the filling of the hollow by detritus poured in at the top, being responsible for their disappearance. Lakes at one time occupied the valleys of the Waimakariri, Rakaia and the Rangitata, so that their condition must formerly, and not so long ago, have resembled those now existing in the Hurunui, Godley, Tasman, and Ohau valleys.

In their higher reaches the lower slopes of the valleys were once bush-clad, but fires have destroyed the covering in most cases or reduced it very considerably so that a distinctive feature of their beauty has disappeared.

It is unfortunate that there are no accurate records of the volume of water discharged by these rivers with the exception of the Waimakariri. The minimum flow at the Otarama Gorge is about 1,200 cusecs, the average flow about 5,000 cusecs, but the flood discharge reaches, if it does not exceed, 150,000 cusecs. The Rakaia, and the Waitaki would give values much in excess of this, while the Rangitata would give results slightly lower.

The lakes existing in the valleys of these rivers are of two kinds, first those occupying main valleys for a considerable part of their length, such as Sumner, Coleridge, Tekapo, and Ohau, and secondly the numerous smaller sheets of water grading down from lakes of tolerable size, such as Lake Heron to those which are mere ponds. The former owe their formation and existence partly to a warping of the valley floor which has formed a hollow, and partly to the erosive action of the glaciers at the time of their main advance combined with the heaping of debris in the form of moraine at the terminations of these glaciers. It is difficult at times to determine the relative importance of each of these causes as they have affected a ponding of the river. Numerous smaller lakes are formed in among the heaps of morainic material, or in short reaches of the main or tributary valleys where the proper flow of water has been interfered with by morainic deposits. Nearly all the main valleys have such lakes, but they are especially numerous where

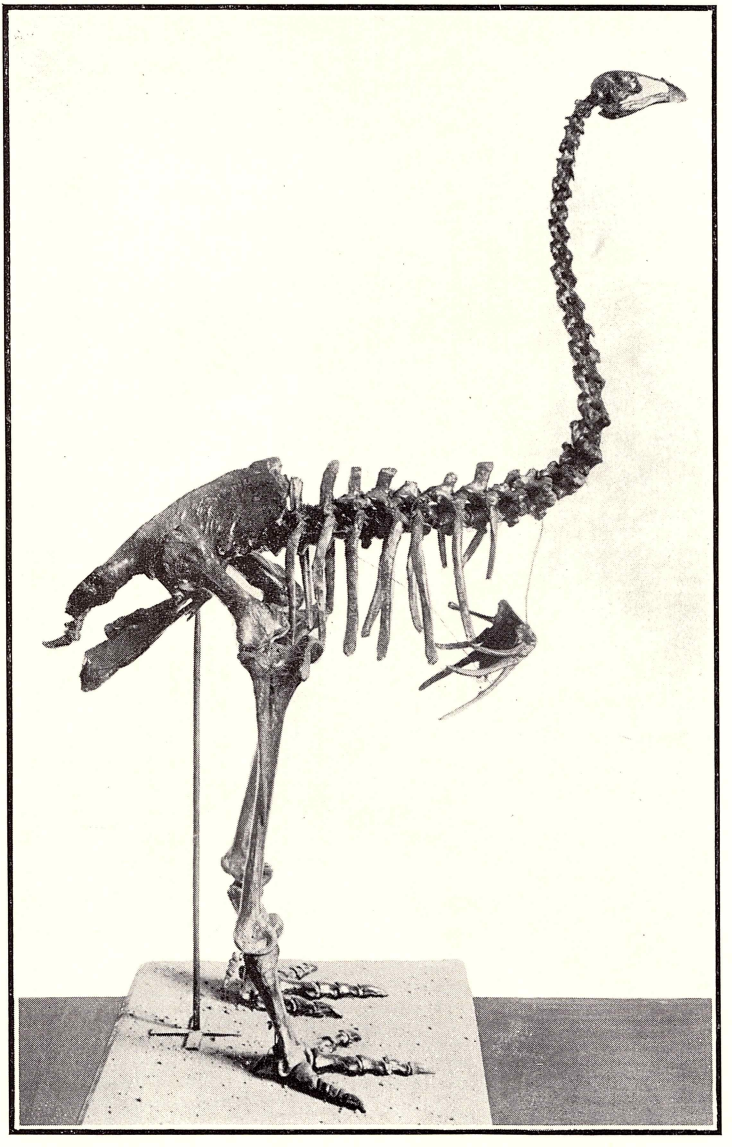
there is a wide floor where the morainic material has been dumped. The most noteworthy examples are those in the Upper Hurunui, in the valleys to the east of Lake Coleridge, and in the Upper Ashburton valley. Some of them are very picturesque, but as a rule they are placed in treeless surroundings like the major lakes of the area.

Appendix on the Extinct Birds of the Province.

The latest phase in the geological history of the province includes a chapter on a number of birds which became extinct before the arrival of the white man, some indeed before the arrival of the Maori. These are a goose *(Cnemiornis calcitrans* also *C. minor)*, a duck *(Anas finschii)*, a rail *(Aptornis otidiformis)*, an eagle *(Harpagornis moorei)* and above all the moa *(Dinornis)* which found the open plains and the tussock clad hill-sides a congenial habitat. Although the first bones submitted to Owen in 1839 came from the neighbourhood of Gisborne, Dr. Lillie of St. Andrew's Church, Christchurch, as far back as 1860 sent numerous specimens to the British Museum, but the greatest stimulus to investigation accrued from the discovery in the year 1866 of the great assemblage in the Glenmark Swamp in North Canterbury, a great proportion of which was secured for the Canterbury Museum and forms the basis of its great collection of moa remains. This was added to from time to time by Haast and it was substantially increased by Hutton by the addition of birds found near Waimate, notably at Kapua. A number of Glenmark bones found their way to England, where they were described by Owen, but some were described by Haast himself. In the year 1891 the collection in the British Museum was overhauled and re-described by Lydekker and his results published in one of the Museum's Catalogues, and simultaneously the great collection in the Canterbury Museum was re-classified by Hutton, who had not only the collections in that museum at his disposal but his work in Otago had rendered him familiar with the forms found in that province, notably in the Hamilton swamp. It is unfortunate that the published results of these two investigators have added something to the confusion in nomenclature already existing and the

unravelment of the tangle awaits accomplishment at the hands of some investigator who has access, not only to the collections in New Zealand, but also to those in museums in Britain and on the continent of Europe.

As a result of the systematic work of the last two workers the family of the *Dinornithidae* has been divided up into five genera (including *Megalapteryx)* by Lydekker and into nine genera by Hutton. Apart from the systematic work, much was done by Haast, Hutton, and Forbes to throw light on various aspects of the natural history of the group. The first named paid particular attention to their association with the early inhabitants of the country, notably by the examination of their old encampments and middens, and by the excavation of the Moabone-Point Cave near Sumner, and he concluded that the moa and an aboriginal race were contemporary, and that the birds formed an important article of food in a land where flesh food, if one excepts birds and fish, was not abundant. Haast's conclusions have to some extent been discounted by the work of H. D. Skinner on the collections in the Canterbury Museum obtained from the Moabone-Point and Monck's Cave, and the latter is of opinion that further evidence is required before the contemporaneity of man and the Dinornithidæ can be regarded as proved, and that the thickness of the deposits in the former cave indicate that the period which has elapsed since the extinction of the moa is at least seven times as long as the "Moa-hunter" period. Hutton in a memorable paper in which he reviewed the whole of the evidence then available bearing on the date of the extinction of the moa came to the conclusion that they probably became extinct between 300 and 400 years ago. If this is true then man and moa must certainly have been contemporaneous in New Zealand. No doubt these birds had a long life in New Zealand and arrived in the country at the early part of the Tertiary era. Some of their bones have been discovered in late Tertiary beds and a notable find was made by Forbes under the dolerite near Timaru where identifiable bones were discovered in tufaceous material probably of early Pliocene age. Several theories have been put forward to account for the decline and extinction of this group of birds apart from their supposed



Skeleton of Moa, Canterbury Museum.

destruction by man, but the one which finds most favour is that based on the existence of a pluvial period, when the climate of the Canterbury area became wet and rainy and probably unfavourable for a bird which preferred open and dry, almost steppe, conditions for its proper development. The existence of a pluvial climate after the retreat of the glaciers is supported by other evidence notably that obtained by Cockayne from the study of leaf forms, etc., of the vegetation of the mountain and plain region of the Province.

The Canterbury Plains.

THEIR ORIGIN AND STRUCTURE.

By Geo. Jobberns, M.A.

The Canterbury Plains extend from the neighbourhood of Amberley to Timaru, being bounded on the east by the Pacific Ocean and on the west by the mountains from which issue the rivers which have built them. Never attaining a greater width than forty miles, they are in the main much narrower than this, comprising an immense lens-shaped alluvial deposit tapering off to the north and the south, and widening in the middle to fill in the shallow sea which once separated Banks Peninsula from the mainland. As the early settlers saw them, they were vastly different from what cultivation and settlement have made them, and it is necessary to remember this when we consider the mode of origin of their surface features. The present article is intended to give only a general account of the origin of the Plains, with some more detailed reference to their main structural units.

The two most conspicuous features are the immense thickness of the gravels, sands and silts of which they are built, and the general slope of thirty to forty-five feet per mile, by which they rise in the west to heights of over a thousand feet. That the material comprising them is the spoil of the dissection of the western mountains is obvious, but the nature of the deposition of it has been a matter of dispute. Hutton always maintained that they originated as a wave-levelled surface slowly reclaimed from the sea by elevation of the land, but von Haast elaborated the theory, now almost generally accepted that, with the exception of certain coastal areas, they consist of vast overlapping shingle fans entirely alluvial in origin. The immense thickness of the gravels is indicated by the fact that borings at Chertsey did not reach solid rock bottom at nearly two thousand feet, but there seems no need to assume that any considerable area of the present surface was ever washed by the sea.

The western mountain ridges are the remnants of an elevated peneplain, from the deep gorges of which came the debris with which the present rivers built up the Plains. But conditions were altogether different then, when maximum fan building took place, for the rivers themselves have since cut deep terraced trenches into the gravels of their own fans. From a paper published by Professor Speight in the *Transactions of the New Zealand Institute* in 1908, describing this terrace development, the following concise explanation of the position is quoted:—"The excess of waste during a period of elevation accounts for the present form of the Canterbury Plains. They have been formed by overlapping fans of great glacier streams, as can be conclusively proved by carefully contouring their surface. The contour lines show them to be formed in exactly the same way as an ordinary shingle fan though their grade is more gentle. They were built up to their present height when the rivers were overloaded with sediment during a period of high land, severe glaciation and acute frost action. On the land being depressed, the supply of waste would fall off and the rivers would begin to terrace their old deposits in a manner analogous to that in which a stream terraces its fan during a falling flood."

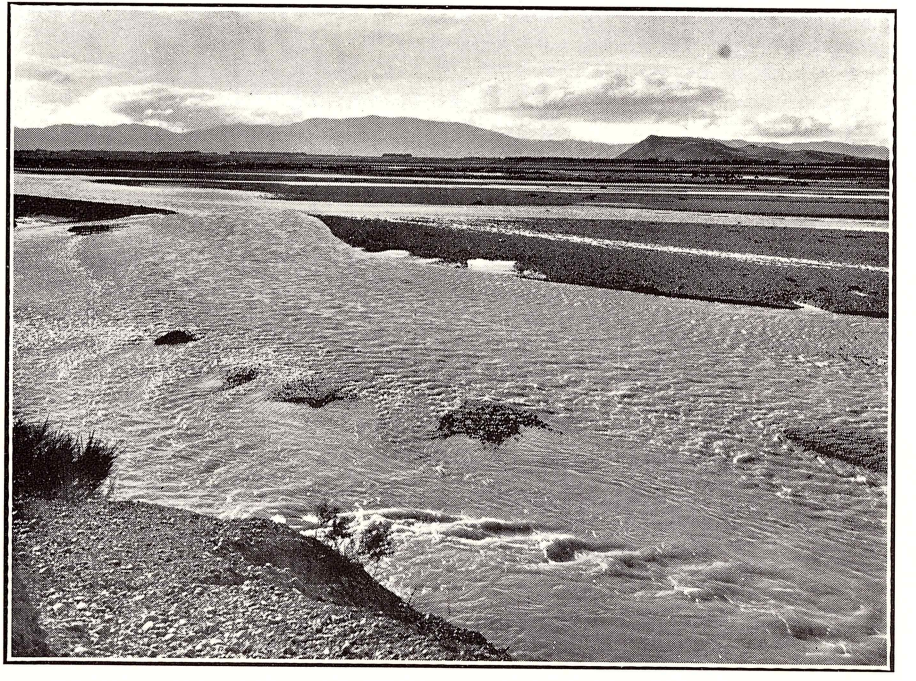
The following structural units form, then, a convenient basis for a more detailed description of local surface features:—

I. The alluvial fans of the great rivers.
II. The depression between the fans.
III. The present river beds.
IV. The coastal lowlands with their sand dunes and peat swamps.

The Great River Fans.

The available data with regard to the slope of the plains and of the rivers entrenched in them may be summarized as follows:—

In Haast's *Geology of Canterbury and Westland*, the figures for the Rangitata, Ashburton and Rakaia rivers show an average slope of 37, 40, and 23½ feet per mile respectively, with the slope of the plains in these localities as 45, 42½, and 39½ feet per mile respec-



[Photo, C. Beken.

River Bed of the Waimakariri River, near Kimberley.

tively. In the case of the Rakaia, recent surveys show the grade of the plains to be somewhat steeper, i.e.—
Mean fall from Gorge to sea —44ft. per mile
Mean fall from Gorge to Railway bridge—50ft. per mile
Mean fall from Railway bridge to sea —29ft. per mile

In the case of the Waimarakiri, the data is more complete:—

Grade of River—

From the Gorge to Courtenay —27ft. per mile
From Courtenay to within 10 miles of sea —28ft. per mile

The grade then flattens gradually to the sea.

Grade of Plains—

(These figures show the mean fall of the plains, not along the course of the river, but at right angles to the contour lines, i.e., in a direction from the Gorge to Lake Ellesmere.)

Mean fall from Upper Gorge (near Kowhai Bush Station) to the sea—34ft. per mile
From near Otarama to plains near the Gorge Bridge —48ft. per mile
From plains near Gorge Bridge to vicinity of Kirwee —35ft. per mile
From Kirwee to Railway at Burnham —36ft. per mile
From Burnham to Selwyn River near Ellesmere Station —25ft. per mile
From Ellesmere Station to the Lake (practically at sea level) —15ft. per mile

Thus the rivers have still a very steep slope where they cross the Plains, but the slope of the Plains themselves is very much greater. So the rivers with diminished volume and lesser loading in their upper courses have not their former fan building power. In the case of the Waimakariri and to a lesser extent the Rakaia, there has been considerable wandering of streams over the middle and lower parts of their fans, before they became more or less permanently established in their present courses. Old river banks and bare stony lands of characteristically recent river bed type indicate that, at no very distant date, the Waimakariri flowed to Lake Ellesmere by a course only a little to the west of Christchurch, and that the Rakaia

too, reached this lake at its northern end at a time when the lake itself extended somewhat further inland.

The gravels of the Waimakariri fan have completely covered the land features of a bygone age though here and there remnants of the older rocks are still visible in such places as View Hill, Burnt Hill, and Gorge Hill. On the higher portions of the fans throughout the Middle Plains, the same conditions obtain as are found along the western edge. The coarse gravel beds, high above the present stream channels, are extraordinarily porous, and rainfall surface water has nowhere been able to establish tributary stream channels arising within the Plains themselves. A typical aridity of the land arises from this, and on both banks of the main rivers the surface is notably more stony upstream, with a general tendency for the northern bank to be always more barren than the southern. In an age when vegetation was scanty and powerless to hold the finer surface silts, the wind lifted these, more especially from the lands to the north, leaving those expanses of stony surface high above the present flood plains of the rivers. Climatic conditions, too, with prevalent nor'-west winds and insufficient rainfall, now as then, are unfavourable to establishment of vegetation and these parts of the Plains are the least closely settled, and the least altered from their primitive state by the advent of the farmer.

The limit of the gravel beds of the Waimakariri fan shows that this did not reach the present coast. But farther south where glaciation was more extensive in the gorges of the Rakaia and Ashburton fan building took place on an enormous scale with a united Rakaia-Ashburton river flowing on a more elevated land surface and spreading its gravel far out beyond the present shore line. The sea cliffs along the Ninety Mile Beach rise from a few feet at the Rakaia Mouth to a maximum of nearly a hundred feet near Wakanui and then diminish in height to the south. Here sea erosion, with a strong northerly current, has cut deeply into the alluvial gravels of the high fan ridge which runs back inland through Chertsey to the Upper Rakaia. That the lower Rakaia River has entrenched itself in the northern side of its fan probably explains

the topography of this area. The front of this fan retreats inland just north of the present Rakaia mouth to join the fan of the Waimakariri somewhere near the point where the railway line crosses the Selwyn River. In the south too, it swings inland towards the Hinds, and we may therefore suppose that the whole of the Plains between the Selwyn and the Hinds consists of one enormous shingle fan with a single important surface depression extending from Methven to Springburn, and lying within the upper junction of the fans of the Rakaia and Ashburton.

The Rangitata fan is built on a somewhat smaller scale but the river and the fan are remarkable for their extra steepness of grade. Haast suggested that the lower part of the fan was continuous northward with that of the combined Rakaia-Ashburton, but to the south of the Rangitata mouth, the river gravels recede inland, giving place to lower estuarine flats of finer silts and muds. In South Canterbury the plains are narrower, the rivers shorter, and fan building is on a miniature scale not extending to the sea. The grade too, is considerably less, high river terraces are absent, and even in the more elevated shingle areas, superficial alluvial silts are more abundant.

The initial structure of the Plains supplies the key to the distribution of soil types, with a remarkable variation from the porous stony surfaces of the upper fans with their thin veneer of silts precariously retained, to those immeasurably richer silt and swamp deposits lying within the junctions of the fans.

Inter-fan Depressions.

The more important areas to be classified thus are:—

I. The Selwyn Basin lying within the junctions of the Rakaia and Waimakariri fans.

II. The Methven, Staveley, Springburn district between the Upper Rakaia and Ashburton.

III. The Basin of the Hinds, within the Ashburton and Rangitata fans above their upper junctions.

IV. Various parts of South Canterbury lying between the more miniature fans of the Orari, Waihi, and Opihi.

Being by structure adapted to the accumulation of ground water and the surface silts from the higher surrounding land, these localities comprise some of the richer lands of the Province, and some have had to be reclaimed from an original swampy condition by artificial drainage. Depressions, obvious in most cases to the eye of the observer, they would best be revealed in nature and extent by contour mapping of the Plains.

The Present River Beds.

With the possible exception of the Waimakariri which deviates somewhat from the general south-easterly direction of the others, and which shows a marked tendency to aggrade its lower channel, the rivers now seem to follow more or less permanent courses. These courses are walled in by steep gravel banks reaching, in the Upper Rakaia, to as much as four hundred feet in height. With a general seaward tapering off in the height of the terraced banks there is a corresponding tendency to lateral extension of the already very wide beds nearer the river mouths. Within their beds the water courses wander capriciously and in times of flood they may extend from bank to bank. In general the material of the valley floor is gravel, often very coarse where the grade is steep, but successive submergings of the flood plains leave a surface film of finer sands and silts. Formerly these superficial deposits were dried and removed almost immediately by the nor'-west winds, leaving the gravels almost as bare as before the floods. But so rapid has been the recent spread of vegetation, particularly since the introduction of gorse and broom, that the flood deposit is now more considerable and so much more permanent, that the nature of the once almost completely barren beds is becoming altogether changed. With the passage of time this change will be more and more manifest, for it is only within a very few years that this flood silt retention has been here a factor in soil development. Within the broad beds of the lower Rangitata, Rakaia and Waimakariri, islands of a somewhat variable fertility have developed as areas isolated by branching of the streams. But still more extensive lands will ultimately be raised above the level of the highest floods, the braided streams being confined in

narrower and more permanent channels. So the gorse, broom and other apparently undesirable vegetation may yet bring considerable areas of waste and altogether stony lands into a state of some fertility. But in the Lower Waimakariri the silting process has recently been abnormal, and it may be suggested that this is, in a measure, due to a quite abnormal development of recently introduced vegetation, chiefly gorse and broom, effecting a complete change from conditions obtaining less than fifty years ago.

Coastal Lowlands.

These are nowhere of any considerable height above the sea and consist almost entirely of finer sands, silts and swamp accumulations, forming a fringe around the edge of the great gravel deposits of the rivers. They extend from the mouth of the Rakaia to the mouth of the Waipara, and also southwards from near the Rangitata mouth to Timaru. A recent upward movement of the land of slight extent is indicated more particularly to the north of Saltwater Creek, where the Main North Road follows the base of the terrace, which continues to the mouth of the Waipara River as the inland edge of a raised sea beach and which, about a mile wide in the north, widens out in the south where the end of the cliff is obscured in sand dunes. Haast supposed that similar recent elevation was in a measure responsible for great reduction in the size of Lake Ellesmere, the junction of Banks Peninsula to the mainland of the Plains, and the consequent natural reclamation from the sea of all that low land in the neighbourhood of Christchurch City. A northerly current formed the broad shingle spit from the Rakaia mouth to Banks' Peninsula, and behind this the formerly more extensive Lake Ellesmere has been filled in with silts and muds from the Waimakariri, Selwyn and Rakaia. Though tongues of fan gravel extend into parts of Christchurch City itself, marine and alluvial silts, swamp deposits, and wind blown sands comprise the lowlands between Lake Ellesmere and the Heathcote Estuary, and northwards to Saltwater Creek.

Sand Dunes.

The sandy shore necessary for the production of these extends from Sumner to Amberley Beach, above which are coarse gravels similar to those of the Ninety Mile Beach. With its sharp reduction of grade a few miles inshore the Waimakariri carries only sands and silts to the sea, where considerable delta building is no doubt going on. But it is probable that a natural grinding of the gravel in its upper and middle course has produced the bulk of the sand of the present shore, it having been distributed southwards by the current, and blown inland by wind to form extensive dunes. At South Brighton, Bromley, Burwood, Linwood, Kaiapoi, and to the north of the Ashley and Saltwater Creek, they have become more or less fixed by vegetation and settlement, but above North Brighton considerable inland drift is still taking place. The former extent of wind blown beach sand is now somewhat difficult to determine, but it is probable that, together with the wind borne loess from the Plains, it aided materially in the infilling of a shallow arm of the sea which once lay around the western base of Banks Peninsula.

In addition to wind blown sand from the shore, dunes of a purely alluvial nature developed farther inland, the source of the sand being the erratic course of the Waimakariri itself. These no doubt had a characteristic linear arrangement, extending southwards into Papanui and Upper Fendalton and through a part of Paparua County. That sand dunes were once the surface cover of such a large area is of course no indication of the width of the true coastal plain, for they spread so far inland and so far up on the front of the Waimakariri fan as to obscure the real extent of the shingle formation. The fact that well borings show extensive gravel deposits well out under the sea at Brighton, indicates the manner in which, on a sinking land surface, the surface features of a former age have been obliterated by enormous accumulation of drift sand. More or less permanent lines of dunes extending for miles inland—drift sand both marine and alluvial in origin—with extensive swamp filled depressions between the ridges, comprised the landscape between the Lower Waimakariri and Lake Ellesmere.

Peat Swamps.

Besides the inland swamp areas to which reference has been made, there are extensive peat deposits in the low coastal lands, more particularly in the neighbourhood of Christchurch. Here they are remarkable for the depth of peat revealed in borings for artesian wells. Peat found to depths of 400 feet at Ward's Brewery, 500 feet at Sydenham, and 700 feet at Islington, indicates that this, essentially a shallow water deposit, must have accumulated on a surface which has subsided to an extent of at least 600 feet. It is this general lowering of the land since the glacial period, which provides an explanation of many of the structural features of the Plains. In South Canterbury it has continued into very recent times resulting in the submergence of forest off the coast at Timaru, and in the partial drowning of much of the lower land in the neighbourhood of Washdyke.

With the exception of the swampy muds forming the borders of Lake Ellesmere, the peat deposits of North Canterbury lie between the lobes of gravel extending from the front of the Waimakariri fan, and in the hollows separating the lines of dunes on the lower coastal lands. Thus, extensively developed around Halswell, the peat occurs in patches throughout Christchurch City and suburbs, through Marshlands to the Waimakariri. The coastal plain increases in height to the north and becomes entirely of a sand dune nature. While in some cases the real extent of the swamps has been obscured by subsequent alluvial deposits, in others the deepening of the bed of the Avon, resulting from recent slight uplift of land, has no doubt led to some modification of them by natural drainage. Closer settlement necessitating drainage, roading and all the changes of surface condition accompanying the growth of the City and its suburbs, have completely obscured the original nature of the drifting dunes and raupo swamps.

The History of Botanical Research in Canterbury.

By R. M. Laing, M.A., B.Sc., F.N.Z. Inst.

Our knowledge of the botany of Canterbury commences with the visit of the French ship *L'Aube* which spent some months in Akaroa, 1840-1841. In January, 1842, it was replaced by *L'Allier*. E. Raoul, who was surgeon to both vessels and a capable botanist, published with the assistance of Decaisne an account of his collections in the *Annales des Science Naturelles*. Series iii., vol. ii.; this was subsequently enlarged and published under the title *Choix de Plantes de la Nouvelle Zélande*. It is an excellent work, and as far as Raoul's own part of it is concerned, accurate. Several species recorded by Raoul from Banks Peninsula have not again been found there, the two most prominent perhaps being, *Pittosporum obcordatum* and *Angelica rosæfolia*. In 1853 the first volume of Sir Joseph Hooker's *Flora Novae Zelandiae* appeared and this includes a description of all New Zealand species known up to that time; but little was known specifically of the Canterbury Flora. How little may be judged by reading a letter written by W. T. L. Travers, addressed to Sir David Monro, and dated, Nelson, Oct. 17th, 1864*. It is entitled *Remarks on a Comparison of the Several Features of the Flora of the Provinces of Nelson and Marlborough with that of Canterbury*. Though Travers had collected in Canterbury, the emptiness of the account shows how little was then known of the vegetation of the district.

One short passage is perhaps worth quoting: "The plains as a rule are destitute of timber, although to the north of Christchurch and in the neighbourhood of Timaru, we still find small patches of forest. In the swampy lands bordering the sea, moreover, at depths varying from four to twenty feet, a vast amount of

*T.N.Z.I., Vol. I. Geographical Botany, p. 19.

buried timber is found, evidently the remains of forests once continuous with the isolated patches still growing; but it is remarkable that though amongst this buried timber considerable quantities of pukatea *(Atherosperma Novæ Zelandiæ)* occur I was unable to find a single tree of that species in any part of the living forest." We know of course that the pukatea does not now exist in Canterbury, and if it did in recent times, then the climate must have been considerably wetter than at present. Though so little was known directly of the vegetation of Canterbury at this time, yet most of the Canterbury lowland species were known indirectly from collections made in other parts of New Zealand. The great gap was due to the fact that nothing was known of the Alpine plants of the Province. Dr. Haast (afterwards Sir Julius von Haast) however in his geological exploration of the Southern Alps, made extensive collections of the mountain plants, and laid the foundations of our knowledge of the Alpine species*, and when the *Handbook of the New Zealand Flora* was published by Sir J. D. Hooker in 1867, the more distinctive species of the Alps had been well discriminated. Henceforward the work was taken up by New Zealand botanists.

In 1870* was published the first paper to be concerned solely with the botany of Canterbury: *On the Vegetation of Christchurch, including Riccarton, Dry Bush, etc.*, by J. F. Armstrong. An interesting note by Dr. Haast, *On the Distribution of Plants in the Province of Canterbury*, prefaces the paper. Mr Armstrong attributes 98 species of flowering plants and ferns to Riccarton Bush, 85 to the Dry Bush on the Christchurch side of the Lyttelton Hills, 59 to Mount Pleasant, and 121 to the Port Hills generally It is impossible to accept some of Armstrong's identifications, and there have been many changes in nomenclature; but after making allowance for necessary alterations and after excepting certain probably wrongly identified species, it is gratifying to know that practically all Armstrong's species are still

*In 1861 on his first Alpine expedition, von Haast was accompanied by Dr. A. Sinclair, an ardent botanist, who was unfortunately drowned in fording the Rangitata. (v. plate p. 98).

*Trans. N.Z. Inst. II, pp. 118-128.

to be found in the neighbourhood of Christchurch, though doubtless much less abundant than they were sixty years ago. Ten years later, in 1880, Mr. J. B. Armstrong published *A Short Sketch of the Flora of the Province of Canterbury, with Catalogue of Species.* This list attributes 350 species of flowering plants to Banks Peninsula, and 750 species to Canterbury Province; and is the only list purporting to deal with whole Canterbury area, that has yet been published. It has however to be used with discretion, as it contains many species particularly in the *Cryptogamic* section, that were not seen by Armstrong. Amongst the flowering plants too there are some species that may well be questioned; *e.g., Ranunculus crithmifolius, Pittosporum obcordatum,* etc. Unfortunately no definite localities are given. However, Armstrong's list is of considerable value to the student of Canterbury botany. In the following year J. B. Armstrong published an account of the genus *Veronica (Hebe),* which is necessary to any student of this difficult genus. In 1882 T. H. Potts, a true lover of nature, published his *Out in the Open, a Budget of Scraps in Natural History.* This contains numerous interesting notes on Canterbury ferns, and some on the flowering plants. In 1887, Mr. L. Cockayne (now Dr. L. Cockayne) commenced his study of New Zealand Botany. Here begins the modern period. Previously botanists had confined themselves to the discrimination of species, often only from dried herbarium material. Mr. R. Brown, of Christchurch, by growing in a moist atmosphere whipcord *Veronicas (Hebes)* obtained from the Canterbury ranges, shewed that the species were plastic, and under such conditions reverted to what was probably an ancestral form, resembling to some extent the ordinary type of leafy plant. This work much interested Dr. Cockayne and was one of the impulses directing his study. Dr Cockayne had come to Canterbury in 1885; and had commenced his botanical work with horticulture, first at the Styx, and later at New Brighton. There in a garden of four and a half acres he collected an immense number of exotic species; and a large number of indigenous Alpine plants, from

*Trans. N.Z. Inst. Vol. XII. pp. 325-353.

Westland, Canterbury, and Otago. His first scientific contribution was read before the Philosophical Institute of Canterbury in 1897. In 1899, he contributed an account of the seedling forms of many native plants, no doubt under the influence of Lubbock's work on the subject. It is difficult however to exaggerate the importance of this approach to botanical study through a new avenue, as he sought to correlate the seedling's form with its natural environment, and thus commenced the study in New Zealand of botany on ecological lines. Since then he has continued his researches up to date, continually breaking fresh ground, and displaying a mind of unusual originality and freshness. It is not too much to say that in certain respects he has brought the botany of New Zealand to the fore-front of the world's investigations; and he has been and is an inspiration to botanical students throughout New Zealand and elsewhere. He continued his studies by a paper dealing with the reproduction after burning of the sub-Alpine scrub on Arthur's Pass; and followed this up with a paper on the *Plant Geography of the Waimakariri River Basin, Considered Chiefly From an Ecological Point of View.* He has been instrumental in the setting aside of typical areas of the plant-associations of the Dominion as sanctuaries for plants and animals. The Waimakariri and Arthur's Pass National Park* is one of the most important in Canterbury, but there are many others. Though his work has been chiefly in the past with Alpine plants, his report on the sand dune coastal areas of New Zealand has been described by an authority as "the fullest and most informing account of the subject available in the English language." In a word, it may be stated, that Dr. Cockayne has raised our knowledge of the botany of the flowering plants of Canterbury to a standard of excellence, probably unsurpassed anywhere. In 1913, Dr. Cockayne, whose work had become of Dominion importance, removed to Wellington.

In 1899, T. Kirk published the first volume of *The Students Flora of New Zealand and the Outlying Islands.* Its completion was unfortunately prevented by his untimely death. Though Kirk had collected but

*Now a scenic reserve.

little in Canterbury, this volume has considerable value for the student of taxonomy. It was superseded in 1906 by Mr. T. F. Cheeseman's classic work *A Manual of the New Zealand Flora.* A second edition of this was in course of preparation, when Mr. Cheeseman died in 1923. It was issued under the able editorship of Mr. W. R. B. Oliver in 1925, and is now the standard taxonomic work on the New Zealand Flora; and it is at least equal in accuracy and completeness to most of the similar European works. Mr. Cheeseman had collected at Mount Cook and elsewhere in Canterbury; and had the advantage of access to the collections of all other New Zealand workers. Consequently his manual contains a complete account up to the date of publication of all known Canterbury species, and must form the basis of all future work on classification.

Meanwhile local students had been at work on other departments of the Canterbury Flora. Dr. L. Cockayne and Mr. C. E. Foweraker have given an account of the vegetation of the Cass Biological Station, Mr. R. M. Laing has listed the species of Banks Peninsula and of several areas in the Southern Alps; Prof. C. Chilton has done similar work for Riccarton Bush, and Prof. Wall and Miss M. Herriott for the vicinity of Christchurch. Prof. Wall has also with tireless energy explored the Alpine districts of Canterbury and other parts of New Zealand, and has added much to our knowledge of the Alpine Floras. The anatomy of local species has been worked out, by Miss W. Betts, Miss A. C. Finlayson, Miss L. A. Suckling, Miss B. D. Cross, Miss E. Pegg and others.

Much work has been done on ecological questions by Dr. H. H. Allan, working in conjunction with Dr. L. Cockayne or independently. His recently published *Vegetation of Mount Peel.* Part I.: *The Forest and Shrublands,* deals with an area of Canterbury, the foothills, which has been too much neglected. We may sum up this brief account, by saying that our knowledge of the native flowering plants of Canterbury is in a well advanced state, and compares more than favourably with the work done in other New Zealand provinces.

The sporophytes of Canterbury are of course much less well known than the spermatophytes, though the

ferns have generally been treated in conjunction with the flowering plants and are equally well known; whilst Dr. Holloway's studies into the development of the Lycopods and the filmy ferns are of the highest importance. In Canterbury Mr T. Naylor Beckett and Mr. R. Brown have done a considerable amount of work on the mosses. Mr. R. M. Laing has collected and described the marine algæ of the district; but nothing has been done locally on the lichens or fungi, and very little indeed on the fresh-water algæ. However, Mr. G. H. Cunningham of Wellington is doing much valuable work on New Zealand Fungi generally, but in all these departments there is abundant need for intensive and extensive work.

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THE BOTANY OF THE CANTERBURY FOOT-HILLS

(Flowering Plants).

The sub-alpine vegetation of Canterbury commences at an altitude of from 3000ft.-4000ft., so that this article will deal briefly with the species found between the top of the plains and the height of about 3500ft. Unfortunately less perhaps is known botanically of this area, than of any other in Canterbury. The most recent article on the subject is Dr. H. H. Allan's *Vegetation of Mount Peel; The Forests and Shrublands.** This supplies a sufficient account for the one district; but for all the other districts no account is available, and the Mount Peel district is by no means typical as the somewhat greater rainfall prevalent there has led to the development of a different type of forest than elsewhere along the foothills. Generally speaking the area is but little forested except in the damper valleys, and on the southern flanks of the spurs where beech forests occur containing chiefly *Nothofagus solandri,* but sometimes also *N. cliffortioides. Nothofagus fusca* is, in addition to the other two, abundant on Mount Grey. Between Mount Torlesse and Mount Peel these forests are smaller in quantity or altogether lacking. The bare tussock clad slopes of the hills do not differ much in their botanical constituents from the upper plains and need not be separately considered, though here and there some of the species of the sub-alpine regions and the fell-fields appear—particularly perhaps in the Malvern Hills.

At Mount Peel there is a podocarp forest very similar to that which once existed on Banks Peninsula, but containing in addition to the species there found the Southern rata *(Metrosideros lucida).* This no doubt is due to the somewhat greater average rainfall of the district than that of Banks Peninsula. The inanga *(Dracophyllum longifolium),* one of the grass trees, absent from Banks Peninsula, is also present at the upper limits of the forest. The rare *Notospartium torulosum,* a pink flowering broom, is occasionally to be found, particularly in the neighbourhood of the Lynn

*1926, T.N.Z.I. p. 37.

stream. *Nothofagus cliffortioides* occurs near the upper forest margin probably as an association relic left in front of the advancing tide of the main forest. With the mountain beech is the parasitic loranth *Elytranthe flavida,* absent from Banks Peninsula. *Nothofagus cliffortioides* appears again at Mount Hutt and Mount Peel, whilst the podocarp forest reappears also at Geraldine behind the township, and at Waimate on the slopes of Mount Studholme.

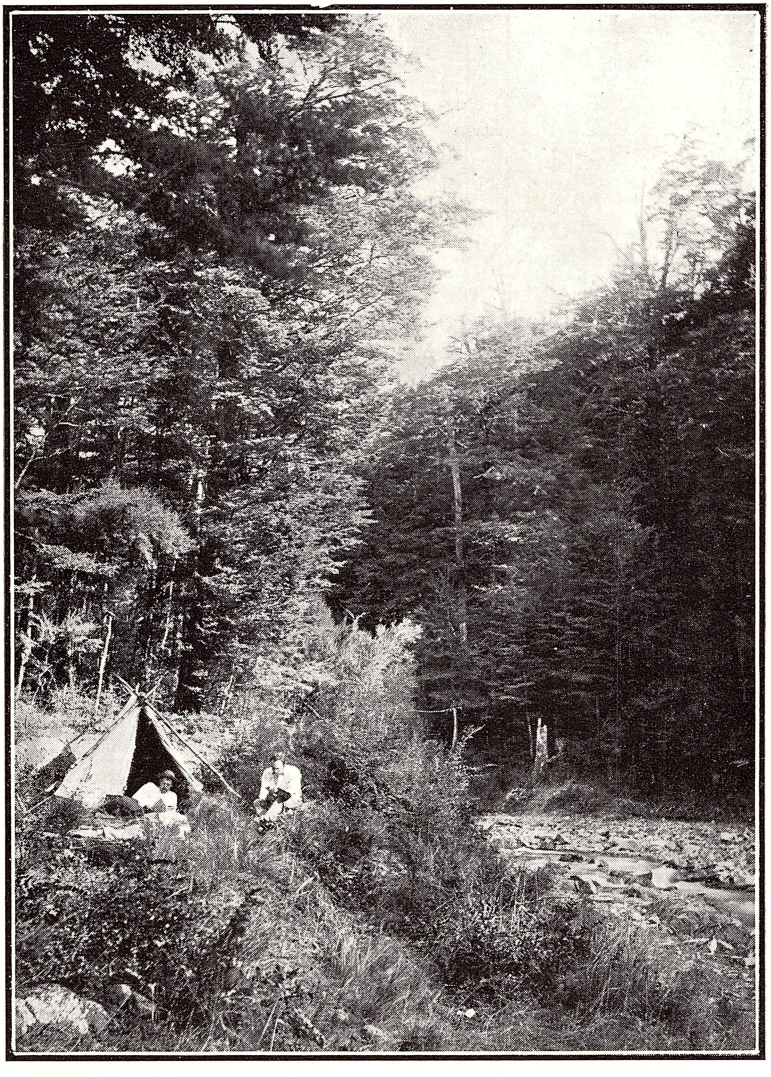
Of course in all these localities there is much indigenous-induced shrublands, which appears after the burning of the forest. At Mount Peel it consists of *Leptospermum scoparium,* and *L. ericoides,* with species of *Raoulia,* little composite patch plants, abundant in river beds, *Leucopogon Fraseri, Gaultheria antipoda* and one or two of the commoner lycopods. This again is very similar to such a heath as is found growing at Wainui, on Banks Peninsula. If we go further north to Mount Karetu, near the head of the Waipara, we find the heath to have a somewhat different constitution. There the scrub, where old and possibly not burnt consists of *Leptospermum scoparium* 12ft. or 15ft. in height and fairly open, with large quantities of *Cyathodes acerosa,* and smaller amounts of *Gaultheria,* together with a species of *Dracophyllum, Celmisia spectabilis,* a common mountain daisy, *Senecio bellidioides,* a daisy like groundsel with a yellow flower; and the xerophytic leafless *Exocarpus Bidwillii* also occur. Where the scrub has been burnt, there grows after several years a dense almost inpenetrable thicket containing in addition to the species mentioned above, *Cassinia Vauvilliersii.* Where freshly burnt *Haloragis depressa,* rushes, and the four-angled sedge *Cladium Vauthiera* are present in quantity. In this district the beautiful broom *Notospartium* again reappears on the banks of the Waipara. Other species here that do not occur on Banks Peninsula are the shrub *Traversia baccharoides,* related to the groundsels, *Coprosma repens,* with beautiful large wine-coloured berries, *Anisotome filifolium,* and the well known *Weinmannia racemosa* or kamahi. Such coastal trees as the ngaio, ake-ake *(Dodonæa)* and even *Pennantia* are wanting from the mountain districts. A little totara, and even smaller quantities of black and

white pine occur here. The larger forests of the Mt. Oxford and Alford districts will be left for discussion under the article on forestry.

Many other species might be listed as occurring in this area, but it would probably serve no useful purpose here. However reference should be made to certain genera and families of herbaceous plants of importance, that have not as yet been touched upon, occurring either on the foothills or on Banks Peninsula or on both. Amongst the Liliaceae, the Maori onion *(Bulbinella Hookeri)* should be mentioned; it is abundant through the foothills, and apparently becoming more plentiful. It is untouched by stock and likely to become a harmful weed. There are also a considerable number of orchids, common throughout the foot-hills and Banks Peninsula; *Microtis unifolia* is perhaps the commonest. Various species of *Pterostylis* with green hooded flowers an inch or more in length and half an inch in diameter are abundant in the damper woods. *Earina,* with waxy white trusses of flowers may also be found epiphytic on trees or growing on rocks. Of the butter-cups, several species are common in the open tussock areas, most abundant are *Ranunculus lappaceus* and *R. hirtus.* The native violets, white and said to be slightly musk scented, are found in the wetter fields or by the sides of streams. *Viola filicaulis* is the most common, but *V. Cunninghamii* also occurs. By the sides of streams also and elsewhere are to be found many species of willow-herbs (Epilobia) with usually white four-petalled flowers, but in *E. junceum* the flowers are often pale rose.

No account would be complete without some reference to the shrubby Hebes (Veronicas) which are to be found in almost all situations. Cockayne and Allan* have endeavoured to end the reign of confusion that exists in this polymorphic genus. and shown that no "herbarium" method of classifying it can prove accurate. *Hebe salicifolia* is of course common throughout the Canterbury district, and includes many distinct forms. These no doubt hybridise freely amongst themselves and with other species. *H.*

*1926, Trans. N.Z. Inst. The present Taxonomic status of the New Zealand species of Hebe.



[Photo, S. Page.

Beech Forest (now destroyed) Paterson's Creek.

leiophylla is common on Banks Peninsula and in many places on the foothills. *H. buxifolia* occurs in the subalpine area on Banks Peninsula and alongside with *H. Traversii* in various forms on the foothills. *Hebe decumbens* another compound species also occurs on rocky places. *Hebe pinguifolia* is found in the gorge of the Orari and its neighbourhood. The name is of course here used to indicate the species in general and not a definite type. *H. pimeleoides* and *H. Raoulii* also occur at White Rock and elsewhere, but it would be dangerous to enlarge this list without full discriminations for which there is no opportunity here. However Canterbury cannot be said to be as rich in endemic forms as parts of Marlborough and Nelson are; but the further exploration of the lowland district between 2000ft.-4000ft. is bound to yield some additional species.

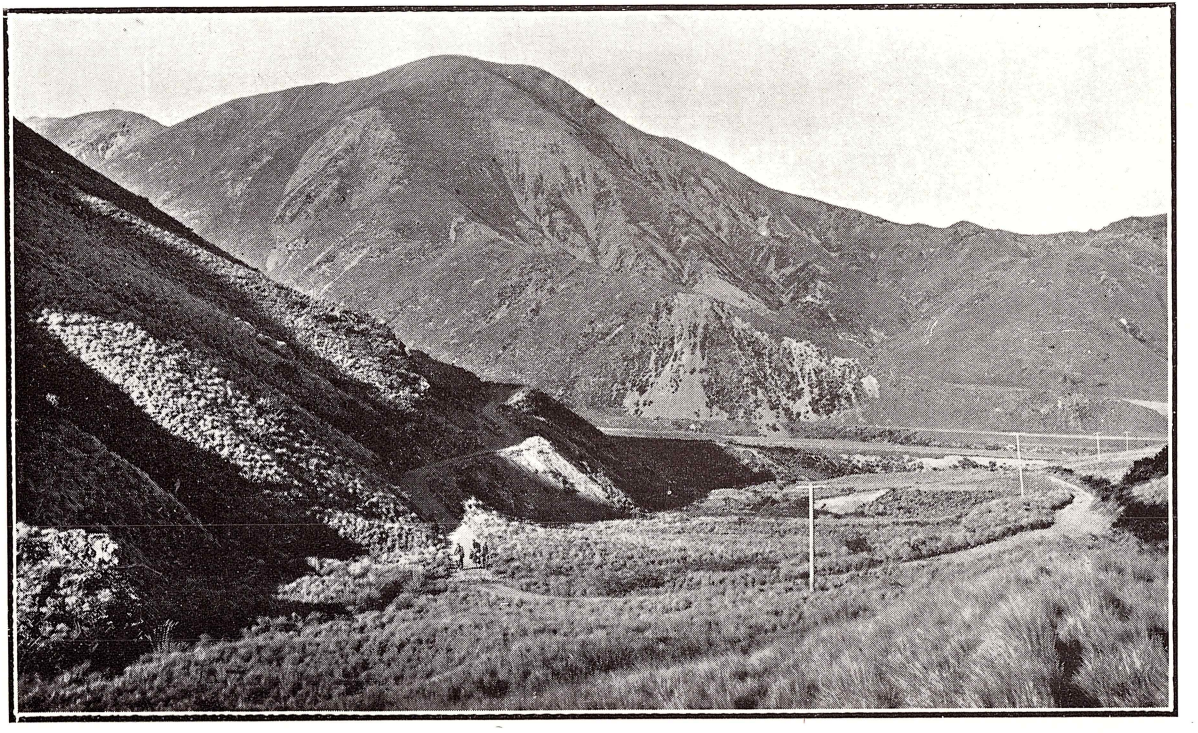
THE BOTANY OF BANKS PENINSULA.
(Flowering Plants).

Banks Peninsula is such a well defined district physiographically and geologically, that it is to be expected that it should also exhibit definite botanical characteristics. While it belongs to the Eastern South Island Botanical district, it forms a distinct portion of that region*. There are three species confined to it or only doubtfully known elsewhere. These are *Hebe (Veronica) Lavaudiana, Celmisia Mackaui,* and *Senecio saxifragoides,* a fourth species, *Cotula Haastii,* is believed to exist also on the Canterbury Plains; but no definite locality is known for it there. *Hebe Lavaudiana* is a beautiful rock plant, a foot or so in height usually growing at an altitude of a thousand feet or more, with thick rounded leaves, an inch to an inch and a half in length, toothed and bearing round the margin a line of brown, often concave on the upper surface, and with a short channelled leaf-stalk. The leaves are confined chiefly to the upper half of the stem, which is stout and woody and not very much branched. In the late spring it bears at the ends of the branches flat clusters of white flowers, pink in the bud, and an inch or two across. It is found near Christchurch only

*Cockayne, 1921, p. 305.

on the harbour side of the Lyttelton hills on the rocky pinnacles and head lands, that rise like little islands above the tussocky ridges. Its nearest relatives are *H. Hulkeana* with beautiful sprays of pale-blue flowers on the Kaikoura coast, and *H. Raoulii* of the foothills on the western side of the plains. *Celmisia Mackaui* is a plant with a still more limited habitat. It is found only on coastal cliffs on the eastern side of Akaroa Harbour, and in one or two places on the northern side of the Akaroa range. Often it lives within the spray of some waterfall, as at Dan Rogers Cliff in Nikau Palm Gully, or in Murderer's Gulley at the back of Gough's Bay. It is a mountain-daisy related to those of the Southern Alps, but quite a distinct species. It has the usual long narrow sword-like leaves of the genus; but in this plant these are recurved at the margins, green on both surfaces, not shining and silvery as in many other species; the midrib is prominent below, often red in colour and passes out into a leaf-sheath which is a dull reddish-brown on both surfaces. The leaves are often a foot in length, running out into a long narrow point with the longitudinal veins ridged on the upper surface. The plant is found from sea-level to about 2000ft.; but is not anywhere abundant. It may be grouped with *Celmisia Hookeri* which comes down to sea-level at Moeraki; but which has leaves green on the upper surface, and white and woolly below; and with *C. coriacea* which has leaves more or less white and silvery on both surfaces, and belongs to the mountains. These plants are all usually termed mountain-daisies, from their big white daisy like flowers.

The third local species is a yellow groundsel, or daisy of even still more restricted habitat. It is only known from the Lyttelton Hills, where it is found growing alongside *Hebe Lavaudiana.* It bears a rosette of elliptical leaves, four or five inches in length with a shaggy wool on the leaf-stalk, and underside of the leaf, and bristly hairs on the upper surfaces of the younger leaves. It is closely related to *Senecio lagopus,* which is abudant on the mountains in other parts of the peninsula and elsewhere. *Cotula Haastii* is a prostrate creeping plant, with pinnatisect leaves,



Mt. Torlesse, with foothills and Tussock Grassland. [Photo, C. Beken.

a couple of inches in length, which when crushed give forth the odour of camomile. It has little greyish white erect flower heads, a quarter of an inch across, and is found on hard, dry ground, particularly on hills overlooking the sea. These four plants constitute the most distinctive element on Banks Peninsula.

But another distinctive feature is the fact that many Northern species here find their southernmost limit. Chief amongst these may be mentioned the native palm or nikau *(Rhopalostylis sapida)*, the true pepper tree *(Macropiper excelsum)*, the karaka *(Corynocarpus laevigata)*, the passion-flower *(Tetrapathea australis)*. Other species, such as the titoki *(Alectryon excelsum)*, the ake-ake *(Dodonaea viscosa)*, the pigeon berry *(Hedycarya arborea)* also find here their southernmost limit on the East Coast, though they go further south on the warmer and wetter West Coast. Thus the presence of certain species unknown elsewhere, and of others unknown further south at once delimits this area botanically. It is further critically delimited by the absence of other species known to the north or south; but as this article is concerned with Canterbury only, these will not be considered here.

Now some four-hundred and fifty species of native flowering plants and ferns are known from Banks Peninsula, and future research is not likely to increase this number very much. This is about one-fourth of the total number of species for New Zealand as a whole. It excludes of course all those plants known only from the warmer regions of the north, the alpine species of the higher elevations, species of the wetter regions, and of the colder south, and those that are highly localised; but it includes generally the typical coastal, forest, and grass-land plants of the New Zealand area; and these will be dealt with at some length.

The coastal plants are not in any way distinctive, and most are widely distributed throughout New Zealand. Omitting the grasses and sedges, the following are perhaps the most characteristic and may be found in abundance. The ice plant *(Mesembryanthemum australe)* with its pink blossoms and thick succulent

leaves, triangular in section, trails downwards over cliffs for many feet or veils the entrance to some rocky shelter or small cave. The native spinach *(Tetragonia expansa)*—not a true spinach at all—is found in somewhat similar situations; whilst on the sand hills below *Convolvulus Soldanella* striped red and white usually appears, and occasionally *Euphorbia glauca* easily recognised as an erect glaucous green semi-shrubby plant with a thick milky juice. More rare and found chiefly on the eastward side of the peninsula is Cook's scurvy grass *(Lepidium oleraceum)* and the pale-blue flowered *Lobelia anceps.* By the sides of beach-streams and in damper places is the little *Selliera radicans,* with a flower which is curiously one sided; and *Samolus littoralis,* with little white flower-cups a quarter of an inch across. *Rhagodia nutans* a trailing herb with succulent leaves and little red berries belongs to the spinach family and is found not only on rocky coasts; but on the cliffs some distance away from the sea. To the same family belongs *Salicornia australis,* the glass wort. It may be found in abundance at the head of tidal flats, such as occur at Teddington or Heathcote, and in company with it, is occasionally to be seen the sea-blite, *Suaeda maritima.* Passing inland, on the margin of tidal streams, such as the Heathcote is the salt-marsh ribbonwood, *Plagianthus divaricatus.* In the coastal scrub, are certain species not commonly found far inland, among them the kawa-kawa *(Macropiper excelsum)* closely related to the plant from which the intoxicating kava of the South Sea Islands is prepared; the ngaio *(Myoporum laetum)* with its gland-dotted leaf comes down to the water's edge. *Dodonaea viscosa,* the ake-ake, with its hop-like fruits is less common than it used to be, but is still to be found in some of the bays round Lyttelton Harbour and more abundantly at Akaroa. The climbing *Angelica geniculata,* related to the aniseed, is also common on the Peninsula coasts, though a comparatively rare plant elsewhere in New Zealand

In the older days in all the moister eastern and southern valleys the coastal scrub passed landward into forest, a forest which has now unfortunately been completely destroyed, only a few imperfect fragments now remaining as evidences of its former glory. The

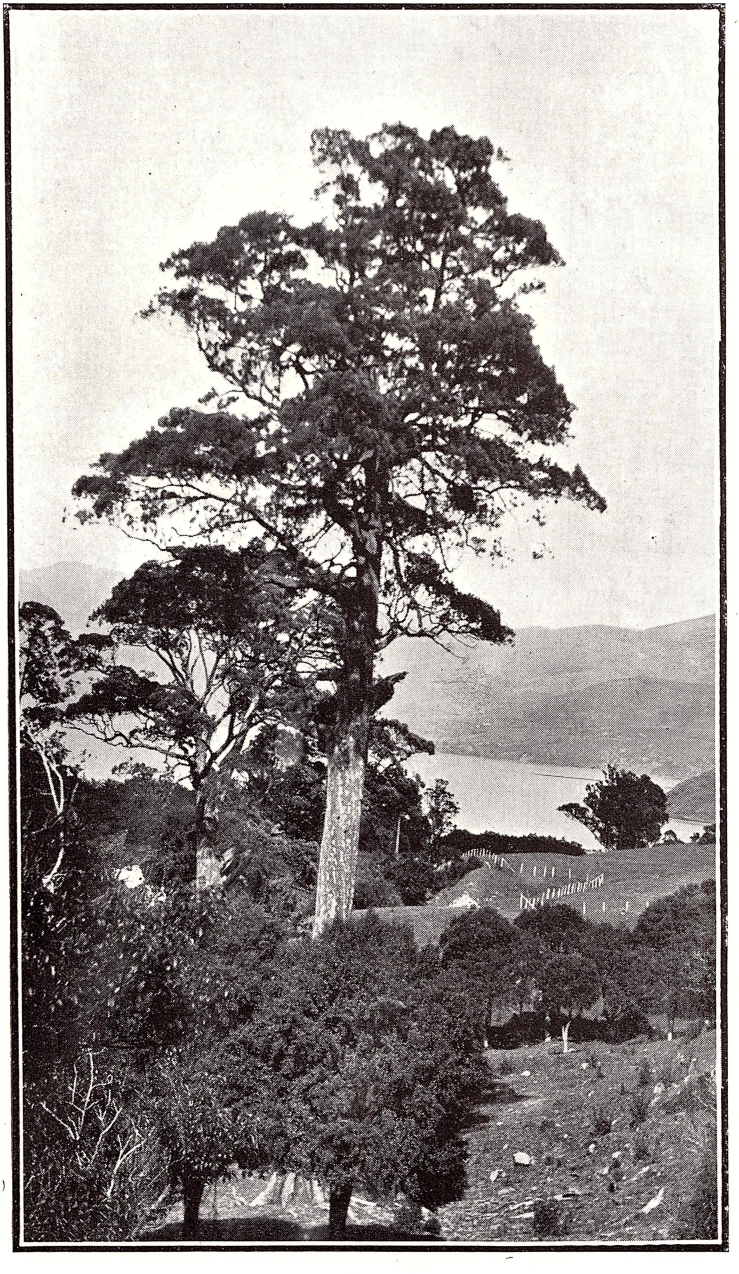
chief timber trees in it were the totara, matai (black pine) and kahikatea, (white-pine) all belonging to the family Podocarpaceae, so it may be termed a podocarp forest. In Little River there was in addition a small amount of rimu (red-pine), only one specimen of which is now known to exist. Of course this type of forest is common throughout New Zealand in most forest areas where the beeches *(Nothofagus)* do not predominate. The beech forests of the peninsula were confined to the heads of one or two valleys behind the township of Akaroa, and to the upper ridges and valleys on the seaward side behind the outer bays from Damon's Bay to Gough's Bay. Here there is still a considerable quantity of beech forest. Probably the best sample of lowland forest in primitive condition still to be found on the peninsula is in Price's Valley to the west of Little River. Fortunately it now strictly preserved. On the valley floor, the large trees are black and white pine with a comparatively small admixture of totara. As the valley narrows the black and white pine trees are replaced by totara, which constitutes the chief timber tree of the hill sides. At about 1500ft. the totara *(Podocarpus totara)* becomes rarer, and it is replaced by the mountain totara *(Podocarpus Hallii)* and round the upper skirts of the forest there is considerable amount of mountain cedar or pahautea *(Libocedrus Bidwillii)*. Similar conditions no doubt prevailed in most of the bays of the peninsula, except where exposed to the parching north west wind, which rendered forest growth impossible.

Though the black-pine *(Podocarpus spicatus)* and the white-pine *(Podocarpus dacrydioides)* with the totara were the chief timber trees of the forest, there was of course a very large admixture of smaller trees in immense variety. Many species of these other trees are still to be found in the scraps of bush that still linger in the hill valleys. The following are everywhere abundant, the mahoe *(Melicytus ramiflorus)*, the broadleaf *(Griselinia littoralis)*, the ivy-tree *(Nothopanax arboreum)*, the lowland ribbon-woods, *(Plagianthus betulinus* and *Hoheria angustifolia)*, the fuchsia *(Fuchsia excorticata)*, the tutu *(Coriaria sarmentosa)*, the kowhai *(Edwardsia micro-*

phylla), Maori may *(Carpodetus serratus),* the kaikomako *(Pennantia corymbosa),* the mako-mako *(Aristotelia serrata)* the patete *(Schefflera digitata),* the lemon wood *(Pittosporum engenioides),* the "matipo" *(P. tenuifolium).* These trees support an abundant growth of lianes, of which the most frequent are species of *Rubus* (lawyer), *Parsonsia* (the native jasmine), *Clematis, and Mühlenbeckia.* Less common are the rata vine *(Metrosideros hypericifolia),* the supple-jack *(Rhipogonum scandens)* and the native passion flower *(Tetrapathea australis),* here at its southern limit. Of these *Clematis indivisa* with sprays sometimes twenty feet long of large white starry blossoms is by far the most handsome. *Clematis foetida* has smaller greenish-yellow flowers, and in spite of its name is strongly and sweetly scented. The supple-jack with its long, black convolutions forming entanglements in the forest is a fast disappearing species from Banks Peninsula, as is also the native passion-fruit, whose handsome, orange-coloured egg like fruits, are now seldom seen.

In more exposed areas or in places where the bush has been felled and burnt, "scrub" is common, consisting of twiggy bushes with small dry hard leaves, and branches that are often wide spread and much interlaced. Here the *Coprosmas* predominate, though there are species from many widely different families intermingled with them. *Coprosma robusta,* the hybrid *C. Cunninghamii, C. areolata, C. virescens, C. propinqua* are all in different places abundant. Intermingled with these are the poataniwha *(Melicope simplex),* the rohutu *(Myrtus obcordata),* more rarely the pedunculate myrtle *Myrtus pedunculata, Helichrysum glomeratum,* and heaths such as manukas and *Leucopogons.* On adjacent or interspersed rocks will be found the korokio, *(Corokia Cotoneaster),* with its little bright yellow starry flowers, and *Hymenanthera crassifolia,* with short, thick-set, spike-like branchlets, and hidden white berries borne on the underside of flattened sprays, that are appressed to the rocks.

In many places where there has been bush there are now large areas of fern-land covered with bracken. These, if neglected, give place in turn to



[Photo, S. Page.

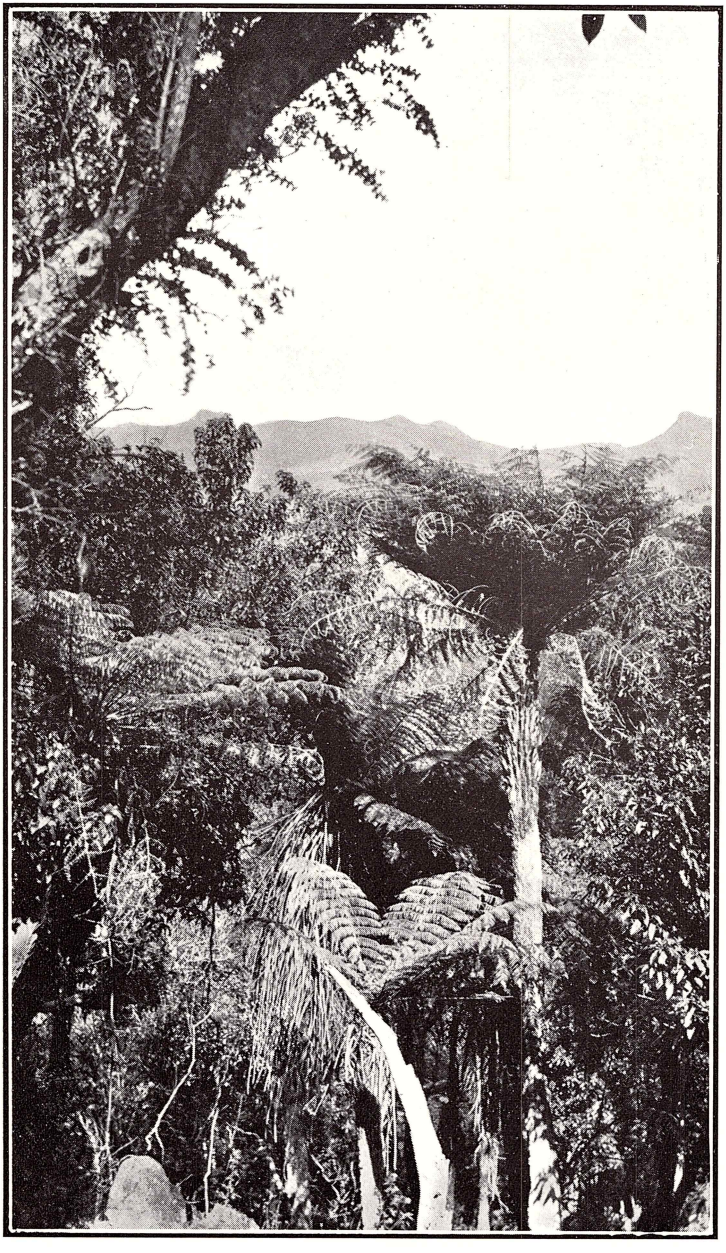
Matai, Eastern Valley, Akaroa.

heaths covered chiefly with manuka *(Leptospermum scoparium)* intermingled with other shrubs such as *Cyathodes acerosa, Gaultheria antipoda* and *Leucopogon fasciculatum.* Such heaths are well developed at Governor's Bay, Port Levy, Duvauchelle's Bay, Barry's Bay and Wainui. In open spaces, both on headlands and in gulleys the native flax *(Phormium tenax)* and the cabbage-tree *(Cordyline australis)* occur sometimes in great abundance; and here too the various tussocks abound. These flourish particularly where the North-West wind has full scope. Hence the Lyttelton Hills to the South of Christchurch have never been fully bush clad; but have always consisted of tussock-grasslands, the chief species being the almost useless *Poa caespitosa.* Other common grasses are *Danthonia pilosa, Danthonia semi-annularis* in various forms, and less common are *Poa Colensoi* and *Agropyron scabrum.* Of course intermingled now with these are many introduced species, and there is also amongst the tussock a small variety of native herbaceous species, such as the Spaniard *(Aciphylla Colensoi)* a disappearing species, the tufted *Scleranthus biflorus,* the little *Convolvulus erubescens,* in spite of its name, here with white flowers only. In this area too are to be found such highly xerophytic shrubs as the Wild Irishman *(Discaria toumatou),* and the native broom *(Carmichaelia subulata).* At heights of 2000ft and upwards the snow grass *Danthonia Raoulii* becomes abundant.

In the centre of the peninsula several hills reach a height of from 2500-3000ft. the chief of these are Mount Sinclair, Mt. Fitzgerald, Mt. Herbert, and Castle Hill. All of these bear on their flattened tops a sub-alpine vegetation consisting of a few striking species. Here is found the broad-leaved cabbage tree *Cordyline indivisa,* an *Ourisia* (often but unfortunately called the mountain primrose or primula), a grass tree *Dracophyllum uniflorum,* the trailing shrub *Drapetes Diffenbachii,* and various other smaller sub-alpine species. Where this vegetation merges into the bush in the centre of the peninsula, may be found a scantily developed sub-alpine scrub, containing such shrubs as the mountain holly, *Olearia ilicifolia,* and a form of *O. cymbifolia.*

It will thus be seen that Banks Peninsula contains a very varied assortment of native plants. The open wind swept faces of the hills support a highly xerophytic flora, whilst in the deep, damp bush-clad valleys of the southern mountain slopes moisture loving ferns and shrubs are to be found.* In the warm almost sub-tropical valleys of some of the sheltered bays, northern species such as the nikau, karaka, and the titoki used to be common, whilst on the wind-swept summits of the central hills, plants of the cold sub-alpine districts of the interior flourish. Unfortunately practically none of the vegetation is left in its primitive condition, and rapid changes are still going on in many places. However the botanical student of Christchurch, who is willing to undertake the time and labour necessary will find on Banks Peninsula a sufficient and interesting introduction to the study of the New Zealand Flora.

*Travers, Trans. N.Z.I. i. Essay p. 19 comments on the absence of filmy ferns.



[Photo, S. Page.

Tree ferns, Akaroa.

The Vegetation and Flora of the Canterbury Plain.

By L. Cockayne, Ph.D., F.R.S.

I. THE VEGETATION.

(a) General.

Here the vegetation is dealt with from the standpoint of succession, such depending either upon geomorphological changes, or upon such as are brought about by the plants themselves, or both classes may come into play. As for the vegetation of the Plains as a whole, it is now so greatly altered that hardly any remains which is truly primitive. All the same, from what is now to be seen in its modified condition, and from earlier records, it is not impossible to reconstruct with some degree of accuracy the original plant-covering. Such reconstruction, then, is my theme, since to attempt an account of the plant-covering as it is at the present time would make a book in itself. For it would have to deal with every class of vegetation from the primitive, or almost primitive, by way of all degrees of modification, up not only to the purely artificial, but to various classes of such after they had been abandoned or neglected.

Taking the primitive vegetation in its entirety, and considering it from the stand-point of succession, it falls into the following series: (1) the tussock-grassland, (2) the aquatic in a wide sense, (3) the forest, (4) the salt swamp-salt meadow, (5) the dune, (6) the gravel coast-line. In what follows the treatment is quite brief; only the more important species are cited, the remainder can be seen in the tabular list which concludes this article, and where their all-important life-forms are described.

(b) The tussock-grassland series.

In the early days of settlement tussock-grassland was *par excellence* the physiognomic feature which

dominated the Canterbury Plain, just as is subtropical rain-forest for that of Westland. It constituted an important part of the great climatic grassland plant-formation which extended unbroken, save by rivers, swamps and patches of forest in the South Island, on the east, from the mouth of the River Wairau to about Palmerston South, and which continued westwards up the river valleys, halting only when forest opposed it at the average limit reached by the westerly rains.

The community under consideration belongs to that class known as "low tussock-grassland" (this name distinguishing it from that type—"tall tussock-grassland"—where much taller tussocks, giant species of *Danthonia*, dominate) which is distinguished by the extreme dominance of tussocks of *Poa caespitosa* and *Festuca novae-zelandiae*, but both need not be present on the same area. Frequently the tussocks would grow so close together that insufficient light would reach the ground to permit the presence of other grasses, herbs, or small shrubs excepting *Agropyron scabrum* —a tussock grass rivalling in size the poa or the fescue —or such plants, as liane-like, could lengthen their stems and so come into the light. But the patch left by death of a tussock—a common circumstance—or ground too stony for the full occupation of tussocks, would be occupied by more or less of the minor members of the community, the names, and life-forms of which can be seen in the List of Species. Tall shrubs and even trees which could overtop the tussocks —originating only where there was sufficient light for their seedlings to develop—would be present here and there, especially the cabbage-tree *(Cordyline australis)*, the kowhai *(Edwardsia microphylla)*—but certainly not everywhere—the manuka *(Leptospermum scoparium)*, the wild-irishman *(Discaria toumatou)* and one or more tall species of New Zealand broom, especially *Carmichaelia subulata*.

Though, as is well known, trees of many kinds grow admirably on the Canterbury Plain, such cannot be established on the open plain by the broadcast sowing of seeds, but young trees must be planted or seeds covered with soil. Still more difficult, nay impossible was it, for true rain-forest trees to be naturally established. Thus it was that the tussock grasses

were able to capture the ground, since they tolerate (not prefer) far drier conditions than do the trees referred to above. Not that the number of rainy days is insufficient for forest but the stony soil is too porous and, above all, the frequent high winds increase transpiration to an extent no rain-forest forest tree can endure.

Mr. G. Jobberns' paper in this book, which I had the advantage of reading in manuscript, gives an admirably clear, yet concise, account of how the surface of the ground now occupied by the plant-covering of the plain was established, and its soils made. Evidently, so far as concerns the tussock-grassland series of successional communities, it matters not whether fan or river-bed was the area to be occupied, the procession of events in these two related geomorphological forms being virtually identical.

As in the days long past, so on the present river-beds can the beginning of tussock-grassland be plainly seen. Nor does it require any botanical knowledge to grasp the fundamentals of the early successions; anyone interested can see it for himself on any of the great river-beds of the plain. Such consist of wide stretches of shingle, quite devoid of plants in those parts subject to floods, but stable enough in places to be occupied by a small, very open plant-association. This invariably consists of certain willow-herbs *(Epilobium)*, their seeds readily brought by the wind, together with silvery-green mats of the moss-like *Raoulia tenuicaulis*. Again and again, this association comes into being only to be destroyed, it leads nowhere but is an end in itself, not a primary succession.

The many streams which occupy only a trifling portion of the river-bed are constantly changing their course, and, by cutting into their bed, portions of the stony ground are left high and dry and may so remain for years. As for the unstable bed, so here for that which is stable, the first comers are the plants already referred to, the willow-herbs and the raoulia, but two mat or cushion species of this genus—*Raoulia lutescens* and *R. australis*—early on put in an appearance and, a little later, comes the far-extending mat-shrub *Muehlenbeckia axillaris*. Such mat and cushion plants, thanks to their trapping the wind-borne silt

(it is this which makes them cushions), form excellent seed-beds in which germinate seeds of many tussock-grassland species, including the tussocks themselves and the wild-irishman. During the early building of the plain seeds would come from plants growing on rocks, etc., adjacent to the fans and, later—as now—there would always be an ample supply from the already populated fans or river-beds.

In short, these two main classes of vegetation would gradually come into being—tussock-grassland (favoured always at first by the presence of its plant seed-beds) and *Discaria* thicket amongst which would grow many grassland shrubs and herbs. These thickets would be confined to the shingly ground and, as they died, would be replaced by tussocks, so that the *Discaria* bushes, now more or less common in tussock-grassland, are merely remnants of a former shrub association.

The constant arrival of wind-borne silt was a most important factor in the establishment of vegetation as, not only did it provide a seed-bed, but it furnished a fairly good soil retentive of moisture and favourable for tussocks to overcome and replace the drought-tolerating species of the stony ground. Yet, even now, there is a distinct plant association on the most stony parts of the plain where are congregated certain true xerophytes, especially the dwarf, leafless, flat-stemmed *Carmichaelia nana* which dominates, thanks to its far-creeping, underground stems, the silvery *Raoulia Monroi,* flat to the ground, and the straggling leafless *Muehlenbeckia ephedroides.* To the north of the River Waimakariri where the stony surface of the plain is at about its maximum much of the silt having blown away there was formerly a very wide area occupied by manuka. Where the silt removal is exceptionally active actual dunes occur on certain old flood-plains and on such grows the rush-like *Scirpus nodosus* in abundance together with *Phormium tenax* and *Edwardsia microphylla.*

An open scrub association would be common on the faces of river terrace made up particularly of *Discaria toumatou,* and rounded entangled bushes of the lianes *Rubus cissoides* (its leafless epharmonic form), *R. subpauperatus* and *Muehlenbeckia complexa* var. *microphylla.*

(c) Vegetation of water, swamp and bog.

Streams and water-holes on old river-bed, shallow streams on the plain and open water of swamps, as in New Zealand generally, possess a vegetation made up of very few species. Where the water is still its surface may be completely hidden by a red, floating carpet of *Azolla rubra.* On the surface of quiet or gently-flowing water float the brown, oval leaves of one or other of the pondweeds *(Potamogeton),* and in the water itself one of the water-milfoils *(Myriophyllum)* the feathery leaves quite submerged or the broader aerial ones raised above the surface.

Extensive swamps, as Mr. Jobberns explains, were a frequent feature of the Canterbury Plain. In the deepest water raupo (vars. of *Typha augustifolia)* would alone be present but, where shallower, there would be plenty of *Phormium tenax* and niggerhead *(Carex secta)* and, near the sea, a fringe of the bulrush *(Scirpus lacustris).* Here and there in the shallower part of the swamp would be the various herbs enumerated in the list of species, including two buttercups and a number of willowherbs of which, when in bloom, *Epilobium pallidiflorum* is particularly striking. As the swamp vegetation died the remains would accumulate on the floor of the swamp forming peat, so that the water-content gradually diminished sufficiently for certain shrubs to gain a footing, especially *Leptospermum scoparium, Hebe salicifolia* var. *communis, Coprosma robusta, C. propinqua* and the series of hybrids between the two last (x *C. prorobusta).* As the water further diminished that tall forest-tree, the kahikatea *(Podocarpus dacrydioides)* would sometimes become established and by degrees the shrub-swamp be transformed to swamp-forest, which, if the soil dried sufficiently would, in its turn, give place to rain-forest proper. As to this having happened on the plain there is not sufficient evidence. On the other hand, the gradual accumulation of peat, led, in some places, to the incoming of *Sphagnum* moss, and bog was the succession. In the early days of settlement there was bog where St. Albans now stands, and much lingered in certain localities till well on into the "nineties" of last century, e.g. at Marshlands, at

Horseshoe Lake and adjacent to the River Styx. On the sphagnum manuka would be dominant, there was a species of *Dracophyllum* and sundews *(Drosera)* and bladderworts *(Utricularia)* were not wanting.

(d.) Forest.

Swamp-forest is known to have occurred near Riccarton, Papanui and Kaiapoi. A portion of the Riccarton forest still remains, since it was carefully preserved by the Deans family who also gave a considerable portion to the people of New Zealand. Would that their spendid, far-seeing example had been followed by others and that other pieces of the primitive vegetation had been unmolested, especially portions of the tussock-grassland!

As a popular account of the Riccarton Bush has been issued by the Bush Trustees (Christchurch, 1924), and as the booklet should be in the possession of every patriotic son and daughter of Canterbury, there is little to say here. Certainly unavoidable drainage has considerably modified the original association, so that some of the members are no longer there and their original presence can only be guessed, still it remains fairly typical swamp-forest with its dominating *Podocarpus dacrydioides* and an occasional matai *(P. spicatus)*. It is ferns which are chiefly lacking, and it is certain that the tree-fern *Dicksonia squarrosa* and the creek-fern *(Blechnum fluviatile)* would be present. On the other hand there is undoubtedly far more of the milk-tree *(Paratrophis microphylla)* than in the primitive association.

From the base of Oxford Hill, forest originally extended on to the plain which contained a good deal of black southern-beech *(Nothofagus Solandri)* and a certain amount of *Podocarpus dacrydioides* and *P. spicatus*, but I refrain from attempting a reconstruction of the original association, though doubtless it would greatly resemble the forest—now nearly all destroyed—which lay between the right-hand bank of the Waimakariri and the base of Mount Torlesse.

(e) Coastal communities.

(1) The Zostera association.

This occurs between tide marks in shallow estuaries. The sole seed-plant is the grass-wrack

(Zostera nana) which forms colonies on the muddy floor through which extend its far-creeping underground stems. At low tide its grassy leaves lie flat on the mud, and when dead are carried by the tide to the shore where they form a brownish belt.

(2) Salt-swamp.

This well-marked association is distinguished by the dominance of either sea-rush *(Juncus maritimus* var. *australiensis)* or the jointed rush *(Leptocarpus simplex)*. It occurs between the tide-marks on the floors of tidal rivers and lagoons. The three-square *(Scirpus americanus)* is the earliest settler, but as the floor of the swamp rises through gradual deposition of mud trapped by the plants, those of the tall rush-form cut off the light and the *Scirpus* is overcome and replaced by the sea-rush or the jointed-rush. Other species enter in as the ground becomes less under the influence of the tide and when this is altogether removed, except under exceptional circumstances, salt-meadow is established. In the swamp *Carex litorosa* is characteristic of fairly deep water and in the transitional girdle connecting salt-swamp and salt-meadow dark colored masses of the divaricating shrub, the shrubby ribbonwood *(Plagianthus divaricatus)* are characteristic.

Where sluggish streams flow through salt-meadow there may be an association with the New Zealand musk *(Mimulus repens)*, its flowers lilac and yellow and the swamp-cotula *(Cotula coronopifolia)*; in deeper and more brackish water is the grass-like sea club-rush *(Scirpus robustus)*.

(3) Salt-meadow.

This plant-formation is characterized by the presence of species—frequently turf-making—which can tolerate an amount of salt in the soil deadly to most species of plants. The association in the area under consideration consists for the most part of an even turf covering the ground, but here and there it is diversified by tussocks of the sea-rush or the jointed-rush in groups or dotted about and globose dark bushes of the shrubby-ribbonwood. According to the domination of *Cotula dioica, Salicornia australis, Samolus repens* var. *procumbens* or the salt-grass

(Atropis stricta) so has the surface of the meadow a different aspect. Occasionally the curious-looking Australian sea-holly *(Eryngium vesiculosum)* is present.

(4) Sand-dunes.

The dune vegetation belongs to two different plant formations, the one of the actual dunes and the other of the hollows, since the two classes are both physiologically distinct and each has a series of successions quite independant and also distinct from those of the other.

Dunes extremely unstable in character both front the sandy plantless shore and, as wandering-dunes, extend inland for a variable distance. Their sole species is the pingao *(Desmoschoenus spiralis)*, a true sand-binder, which grows upwards out of the sand as fast as it is buried, and extends over amazing areas by means of its very stout, flexible, much-branching underground stem. With a shade more stability the sand-spurge *(Euphorbia glauca)* comes in, and where a trifle more stable still the sand-catching shrub, *Coprosma acerosa*, the shore-convolvulus *(Calystegia Soldanella)* and perhaps the golden tauhinu *(Cassinia fulvida)* gain a footing. Should these be able to grow closely fair stability is assured.

As the unstable dunes blow away—a constant occurrence—a basin-like sand-hollow is formed or, where whole chains of dunes have disappeared, a sand-plain. In such there is stability of the surface, since the floor is moist through close proximity to the water-table. If sand is blown into these hollows the creeping sand-sedge *(Carex pumila)* soon puts in an appearance, its seeds brought by the wind, and catching the flying sand, it builds miniature dunes on which eventually the pingao may settle. Where, however, the hollow remains moist a well-marked association is soon established in which there are large circular mats of the sand-gunnera *(Gunnera arenaria)* and various salt-meadow plants, including the jointed rush. Where a hollow or sand-plain has not been invaded by sand for a considerable time there will be close thickets of manuka and other shrubs including the wild-irishman and the golden tauhinu.

(5) Vegetation of stony debris near the sea.

The coast-line of the Ninety-mile beach consists of shingle. There are the following distinct habitats: shingly shore, shingle-terrace, shingle-cliff (in places much loess is mixed with the stones) and ground on the summit of the cliffs subject to more or less wetting by sea-spray.

Evidently ground of such a stony nature is somewhat ecologically similar to river-bed, and it is consequently occupied in part by such river-bed species as tolerate a certain amount of sea-spray, e.g., to cite several, *Muehlenbeckia axillaris, M. ephedroides, Scleranthus biflorus, Carmichaelia subulata, Geranium sessiliflorum, Oxalis corniculata, Epilobium pedunculare, E. microphyllum, Raoulia lutescens* and *R. Monroi.* Belonging to the same category are the river-terrace shrubs *Rubus subpauperatus,* epharmonically leafless *R. cissoides, Coprosma propinqua* and *C. crassifolia.* On the other hand, various true coastal species are present especially: *Zoysia pungens, Festuca littoralis, Carex pumila, Juncus maritimus* var. *australiensis, Triglochin striata* var. *filifolia, Atriplex Buchanani, Rhagodia nutans, Tetragonia expansa, Hymenanthera crassifolia, Linum monogynum, Eryngium vesiculosum, Calystegia Soldanella, Cotula dioica* and *Senecio lautus.*

From information supplied by Dr. H. H. Allan on the vegetation of the summit of the shingle-cliffs there is in places *Poa caespitosa* grassland containing a surprising amount of *Brachycome pinnata*—the plants quite uniform and absolutely distinct from *B. Sinclairii.* Where storms have removed the grassland, and the loess is exposed, there may be pure colonies of *Atriplex Buchanani* or with it may be mixed *Rhagodia nutans* and *Atropis stricta* var. *suborbicularis.* But where the loess has been blown away the stones laid bare, especially in shallow hollows, there is an open community of the small, pale-green cushions of *Agrostis muscosa,* larger yellow cushions of *Scleranthus biflorus,* the dull brownish-green rosettes of *Eryngium vesiculosum,* mats of *Claytonia australasica* and tiny cushions of an unidentified grass, which may be *Poa maniototo.*

II. THE FLORA.

(a.) General Statistics.

Here, as in Part I., only the vascular plants, ferns, their allies and seed-plants are dealt with. These consist of 341 species, i.e. only about 27 per cent. of the total coastal and lowland floras of North, South and Stewart Islands—a fact already indicated by the general uniformity in ecological conditions for the area. These 341 species consist of 23 ferns and fern-allies, 3 gymnosperms, 96 monocotyledons and 219 dicotyledons; they belong to 73 families and 185 genera of which the largest, together with the number of species in each, are as follows: (families), *Cyperaceae* (sedges) 36, *Compositae* 31, *Gramineae* (grasses) 28, *Filices* (ferns) 22, *Onagraceae* 19, *Rubiaceae* 14 and *Ranunculaceae* and *Rosaceae* each 10,; (genera) *Carex* 18, *Epilobium* (willowherbs) 16, *Coprosma* 11, *Cotula* 7, and *Juncus* (rushes), *Muehlenbeckia*, *Ranunculus* (buttercups) and *Carmichaelia* each 6. Had I included the plain at its junction with the foot-hills of the Southern Alps a good many more species would have been included, but such treatment would give a wrong idea of the flora of the area. Doubtless, too, the forests, swamps and bogs of the primitive plain would contain species now extinct for the area. There must also be species which have not yet been noted, and there are undoubtedly more hybrids than are included in my list, but the study of these is yet in its infancy.

LIST OF SPECIES, ETC., TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
Filices.			
Polystichum vestitum Presl.	Prickly shield-fern	Large tufted fern sometimes with a trunk.	Forest.
——— Richardi (Hook. f.) Sm.	Black shield-fern	Medium-sized tufted fern.	Forest.
Dryopteris pennigera (Forst. f.) C. Christen.	Feather-fern	Large tufted fern frequently with a slender trunk.	Forest.
Asplenium flabellifolium Cav.	Necklace-fern	Slender prostrate fern rooting at tips of leaves.	Forest; above coastal shingle cliff beneath Discaria.
——— bulbiferum Forst. f. (A compound species made up of many jordanons between which hybrids are common; it also crosses with A. flaccidum and A. Hookerianum).	Common-spleenwort	Generally a rather large tufted fern.	Forest.
——— Hookerianum Col.	Maidenhair-spleenwort	Small, tufted fern	Forest.
——— flaccidum Forst. (a compound species of many jordanons between which hybrids are frequent.)	Pendant-spleenwort	Epipytic pendulous or erect tufted ground-fern	Forest.
Blechnum penna marina (Poir.) Kuhn	Alpine hard-fern	Small, creeping fern.	Forest.
——— procerum (Forst. f.) J. C. Anders.	Kiokio	Small, to extremely large creeping fern.	Swamp; forest.
Pellaea rotundifolia (Forst. f.) Hook.	Round-leaved pellaea	Erect, creeping fern.	Forest.
Cheilanthes Sieberi Kunze	Common lip-fern	Small, tufted, creeping fern	Tussock, grassland, in stony ground; river-bed.
Hypolepis rugulosa (Thunb.) J. Sm.	Hairy boss-fern	Tall, creeping, glandular hairy fern.	Forest.
——— tenuifolia (Forst. f.) Bernh.	Thin-leaved hypolepis	Medium-sized, creeping fern.	Forest.
Histiopteris incisa (Thunb.) J. Sm.	Water-fern	Tall, far-creeping fern.	Open places in forest.
Pteridium esculentum (Forst. f.) Ckn.	Bracken	Very tall, far-creeping fern.	Sunny places in forest; river terrace; tussock grassland; dune hollow or sand-plain.
Polypodium diversifolium. Willd.	Creeping polypody	Epiphytic or climbing fern with fleshy rhizome.	Forest.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
Cyclophorus serpens (Forst. f.) C. Christen	Thick-leaved polypody	Small, epiphytic, creeping, thick-leaved fern.	Forest.
Ophioglossum coriaceum. A. Cunn.	Austral adder's-tongue	Very small, summergreen fern with 1 or 2 entire leaves.	Tussock-grassland.
——— minimum J. B. Armstg.	Little adder's-tongue	Very small, summergreen fern with 1 or 2 entire leaves.	Tussock-grassland.
——— pedunculosum Desv.	Larger adder's-tongue	Taller and with broader leaves than O. coriaceum.	Tussock-grassland.
Botrychium australe R. Br.	Austral-moonwort	Small summergreen fern with one much-cut leaf.	Tussock-grassland.
——— ——— var. millefolium Prantl.	Parsely-moonwort	Small summergreen fern with leaf cut extremely finely.	Tussock-grassland.
Salviniaceae.			
Azolla rubra R. Br.	Red water-fern	Minute gregarious, floating plant, making red masses.	Still water.
Podocarpaceae.			
Podocarpus totara D. Don ex Lamb	Totara	Tall, massive tree.	Forest.
——— spicatus R. Br.	Matai	Tall tree.	Forest.
——— dacrydioides A. Rich	Kahikatea	Tall tree.	Forest.
Typhaceae.			
Typha angustifolia L. var. Muelleri (Rohrb) Graeb.	Raupo	Tall, summergreen reed.	Swamp.
Scheuzeriaceae.			
Triglochin striata Ruiz et Pav. var. filifolia Buchen.	Three-ribbed arrow-grass	Small, creeping, grass-like plant.	Salt-meadow; sandy-shingly shore.
Potamogetonaceae.			
Potamogeton Cheesemanii A. Benn.	Common-pondweed	Water-plant with floating leaves.	Still or gently-flowing water.
——— ochreatus Raoul	Blunt-leaved pond-weed	Submerged water-plant	Rivers.
——— pectinatus L.	Fennel-leaved pond-weed	Submerged water-plant with very fine leaves.	Brackish water.
Althenia bilocularis (T. Kirk) Ckn.	Thread-like pondweed	Submerged water-plant with filiform stems and leaves.	Brackish water.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc
Ruppia maritima L.	Tassel-pondweed	Submerged water-plant with filiform stems and leaves.	Brackish water.
Zostera nana Roth	Sea-wrack	Submerged grass-like creeping plant.	Lagoons between tide-marks.
Gramineae.			
Zoysia pungens Willd.	Mat sand-grass	Small creeping grass.	Dune hollow.
			Sandy-shingly shore.
Spinifex hirsutus Labill.	Silvery sand-grass	Large sand-binding grass	Unstable dunes.
Microlaena avenacea (Raoul) Hook. f.	Forest-grass	Medium-sized tufted-grass.	Forest.
——— stipoides R. Br.	Meadow rice-grass	Medium-sized, creeping grass.	Tussock-grassland.
Hierochloe redolens (Forst. f.) R. Br.	Holy-grass	Tall, sweet-scented, far-creeping grass.	Moist ground.
Echinopogon ovatus Beauv.	Rough-bearded grass	Rather small tufted-grass.	Tussock-grassland.
Agrostis retrofracta Willd. (= Deyeuxia Forsteri Kunth.)	Southern-bent	Medium-sized, tufted-grass.	Dune hollow; tussock-grassland.
———muscosa T. Kirk	Pincushion-grass	Small cushion plant.	
——— Billiardieri R. Br.	Sand-bent	Medium-sized tufted-grass with flat leaves.	Dune hollow.
———avenoides (Hook. f.) Buch. var. brachyantha Hack. ex Cheesem.	Oat-bent	Fairly tall tufted-grass.	Tussock-grassland.
Dichelachne crinita (Forst. f.) Hook. f.	Plume-grass	Fairly tall tufted-grass.	Tussock-grassland.
Deschampsia caespitosa (L.) Beauv.	Tufted hair-grass	Tall tussock-grass.	Sandy semi-salt meadow.
Trisetum antarcticum (Forst. f.) Trin.	Common oat-grass	Medium-sized tufted-grass	Tussock-grassland.
Danthonia semiannularis R. Br.	Tufted danthonia	Small tufted-grass.	Tussock-grassland.
———pilosa R. Br.	Danthonia	Small turf-making grass	Tussock-grassland.
——— Buchanani Hook. f.	Otago danthonia	Small tufted-grass.	Tussock-grassland (very rare).
Arundo conspicua Forst. f.	Toetoe	Huge tussock-grass.	Swamp; margins of streams.
Triodia exigua T. Kirk	Mountain-twitch	Turf-making grass.	River-bed.
Poa caespitosa Forst. f.	Poa-tussock	Medium-sized tussock-grass.	Tussock-grassland; dune hollow; coastal shingle-terrace.
——— Colensoi Hook. f.	Blue-tussock-grass	Small tussock-grass.	Tussock-grassland.
——— intermedia Buch.	Large blue-tussock	Medium-sized tussock grass.	Tussock-grassland.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
——— Lindsayi Hook. f. . . .	Brown-poa	Small tufted-grass.	River-bed; tussock-grassland.
——— maniototo Petrie . . .	Desert-poa	Small cushion-grass.	Tussock - grassland (very rare).
Atropis stricta (Hook. f.) Hack. ex Cheesem.	Salt-grass	More or less prostrate tufted-grass.	Salt-meadow.
——— var. suborbicularis Hack. ex Cheesem.		More or less prostrate tufted-grass.	Coastal "loess" cliff.
Festuca novae-zelandiae J. B. Armstg. .	Fescue-tussock	Medium-sized tussock-grass.	River-bed tussock-grassland.
——— littoralis Lab.	Sand-fescue	Medium-sized tussock-grass.	Dune; gravel beach.
Agropyron scabrum (Lab.) Beauv. . . (A compound species made up of jordanons of different life-forms).	Bluegrass	Medium-sized tussock or more or less prostrate.	Tussock - grassland; gravel-beach.
Cyperaceae.			
Heleocharis acuta R. Br. . . .	Austral spike-rush	Creeping tufted-rush.	Swamp; margin of streams.
——— Cunninghamii Boeck . . .	Slender spike-rush	Creeping rush.	Swamp; margin of streams.
Scirpus cernuus Vahl.	Dwarf Club-rush	Very small, slender tufted-rush.	Wettish ground; dune hollow.
——— basilaris (Hook. f.) C.B. Clarke ex Cheesem.	Little club-rush	Very small, densely-tufted, slender rush.	Swamp.
——— inundatus Poir. . . .	Swamp club-rush	Slender, rush-like plant.	Shallow streams; swamp.
——— sulcatus Thouars var. distigmatosa C. B. Clarke ex Cheesem. . .	Water club-rush	Small, tufted, rush-like plant.	Swamp.
——— nodosus Rottb. . . .	Common club-rush	Medium-sized tussock-rush.	Sand-hollow; river-bed.
——— americanus Pers. . . .	Three-square	Erect creeping rush with triquetrous stems.	Salt-swamp.
——— lacustris L.	Great-bulrush	Very tall creeping rush.	Shallow river.
———robustus Pursh. . . .	Salt club-rush	Summergreen creeping grass-like plant.	Salt-swamp.
Desmoschoenus spiralis (A. Rich.) Hook. f.	Pingao	Far-creeping sand-binding sedge.	Unstable dune.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
Schoenus axillaris Poir.	Slender beaked-rush	Small, slender creeping-rush.	Margins of streams; damp river-bed.
Schoenus pauciflorus Hook. f.	False snow-grass	Medium-sized, rush-tussock.	Swamp.
——— nitens (R. Br.) Poir var. concinnus (Hook. f.) C. B. Clarke	Dwarf beaked-rush	Very small, wiry, creeping rush.	Dune-hollow.
Cladium glomeratum R. Br.	Swamp twig-rush	Medium-sized, creeping tufted-rush.	Swamp.
——— Vauthiera C. B. Clarke ex Cheesem.	Square-stemmed twig-rush	Small, tufted, square-stemmed creeping rush.	Dune-hollow.
Uncinia uncinata (L.f.), Kükenth.	Common hooked sedge	Medium-sized tufted grasslike-plant.	Forest.
——— leptostachya Raoul	Tall hooked-sedge	Medium-sized tufted grasslike-plant.	Forest.
Carex virgata Sol. ex Hook. f.	Slender nigger-head	Tall grasslike sedge.	Swamp.
——— secta Boott	Nigger-head	Tall grasslike sedge with stout trunk.	Swamp.
——— resectans Cheesem.	Desert-sedge	Grassy mat-plant.	Tussock-grassland.
——— Colensoi Boott	Grassland-sedge	Small creeping sedge.	Tussock-grassland.
——— stellulata Good.	Prickly-sedge	Small, tufted-sedge.	Swamp.
——— Gaudichaudiana Kunth.	Bog-sedge	Small, creeping, grassy sedge.	Bog; swamp.
——— subdola Boott	Larger bog-sedge	Medium-sized, creeping, grassy sedge.	Bog; swamp.
——— ternaria Forst. f.	Cutty-grass	Rather tall, creeping grassy sedge.	Swamp; dune; tussock-grassland.
——— testacea Sol. ex Boott	Slender-sedge	Rather tall, tufted-sedge.	Dune; tussock-grassland.
——— lucida Boott	Shining-sedge	Rather tall, grasslike, sedge-tussock.	Dune hollow; river-bed; tussock grassland.
——— Buchanani Bergg.	Red tussock-sedge	Rather tall, reddish sedge-tussock.	Swamp; running water.
——— litorosa Bailey	Sea-sedge	Small sedge-tussock.	Salt-swamp.
——— Lambertiana Boott	Forest-sedge	Tall, grassy sedge-tussock.	Forest.
——— breviculmis R. Br.	Small grassland-sedge	Very small, grassy, tufted-sedge.	Tussock-grassland.
Carex pumila Thunb.	Sand-sedge	Small, far-creeping, sand-binding grass-like plant.	Dune-hollow; sandy, stony beach.
——— Solandri Boott		Medium-sized, densely tufted grasslike plant.	Forest.
——— Oederi Retz. var. cataractae (R. Br.) Kükenth.	Yellow-sedge	Very small tufted grasslike plant.	Swamp.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
——— pseudo-cyperus L.	Cyperus-sedge	Tall, tufted, grasslike plant.	Swamp.
Lemnaceae.			
Lemna minor L.	Duckweed	Gregarious, minute, floating water-plant.	Still water.
Restionaceae			
Leptocarpus simplex A. Rich.	Jointed-rush	Tall, creeping, stiff, rush-like plant.	Salt - swamp; salt-meadow. Dune hollow.
Juncaceae.			
Juncus pauciflorus R. Br.	Slender-rush	Slender tussock-rush.	Tussock-grassland.
——— vaginatus R. Br.	Austral-rush	Tall tussock-rush.	Wet ground.
——— polyanthemos Buchen.	Common-rush	Medium sized tussock rush.	Wet ground.
——— maritimus Lam. var. australiensis Buchen.	Sea-rush	Tall tussock-rush.	Salt - swamp; salt-meadow; coastal shingle-cliff.
——— planifolius R. Br.	Grass-rush	Small, tufted, grass-like plant.	Moist ground.
——— novae-zelandiae Hook. f.	Mountain-rush	Very small, mat-forming creeping rush.	River-bed.
Luzula campestris L. (several varieties and hybrids between them.)	Wood-rush	Small, tufted, grass-like plant.	Tussock-grassland.
——— ulophylla (Buchen.) Ckn.?	Silvery wood-rush	Small, hairy, grasslike-plant.	Tussock-grassland.
Liliaceae.			
Cordyline australis (Forst. f.) Hook. f.	Cabbage-tree	Low, tuft-tree.	Swamp; tussock-grassland.
Astelia nervosa Banks et Sol. ex Hook. f. var sylvestris Ckn. et Allan	Common-astelia	Massive tussock.	Swamp ;forest.
Phormium tenax Forst.	New Zealand flax	Immense, Iris-like tussock.	Swamp; dune-hollow.
Chrysobactron Hookeri Col. ex Hook. var. angustifolia Ckn. et Laing	Bog-lily	Summergreen, tufted herb.	Tussock - grassland; where moist.
Iphigenia novae-zelandiae (Hook. f. ex T. Kirk) Baker	Fairy-lily	Very small, summer green herb, with 2-3 narrow leaves.	Swamp; wet ground.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
Amaryllidaceae.			
Hypoxis pusilla Hook. f.		Very small, summergreen herb with 3-6 wiry leaves.	Tussock-grassland.
Iridaceae.			
Libertia peregrinans Ckn et Allan	Sand-libertia	Medium-sized far-creeping herb with stiff leaves.	Dune-hollow.
Orchidaceae.			
Spiranthes australis Lindl.		Small earth-orchid.	Tussock-grassland.
Thelymitra longifolia Forst.	Maikuku	Small earth-orchid.	Tussock-grassland.
Microtis uniflora (Fort. f.) Reichenb.	Onion-leaved orchid	Slender earth-orchid with fistular leaf.	Tussock-grassland.
Prasophyllum Colensoi Hook f.		Small earth-orchid.	Beneath Discaria in tussock-grassland
Pterostylis foliata Hook. f.		Small earth-orchid.	Summit of coastal shingle-cliff.
——— mutica R. Br.		Very small earth-orchid.	Beneath Discaria in tussock-grassland.
Caladenia Lyallii Hook. f.	Alpine caladene		Leptospermum shrub-land.
Fagaceae.			
Nothofagus Solandri (Hook. f.) Oerst.	Black southern-beech	Medium-sized tree.	Forest of upper plain.
Moraceae.			
Paratrophis microphylla (Raoul) Ckn.	Milk-tree	Small tree with divaricating juvenile form.	Forest.
Urticaceae.			
Parietaria debilis Forst. f.	Pellitory	Slender, flaccid herb.	
Loranthaceae.			
Loranthus micranthus (Hook. f.)	Common mistletoe	Shrubby hemi-parasite.	Forest.
Tupeia antarctica (Forst. f.) Cham. et Schlch.	Pirita	Shrubby hemi-parasite.	Forest.
Korthalsella Lindsayi (D. Oliver) Engl.	Jointed mistletoe	Very small, flat-stemmed, woody hemi-parasite.	Forest.
Polygonaceae.			
Rumex flexuosus Sol. ex Forst. f.	Wiry-dock	Low, branching herb.	Tussock-grassland; coastal shingle-cliff.
Muehlenbeckia australis (Forst. f.) Meissn.	Large-leaved pohuehue	Winding liane.	Forest.
——— complexa (A. Cunn.) Meissn	Pohuehue	Winding liane.	Forest.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
——— ——— var. microphylla (Col.) Ckn.	Small-leaved pohuehue	Shrub with tangled flexible stems.	River terrace; coastal shingle-terrace.
——— axillaris (Hook. f.) Walp . .	Creeping-pohuehue	Mat-forming, creeping shrub.	River-bed; stony ground in tussock-grassland; coastal shingle terrace.
——— ephedrioides Hook. f. . . .	Leafless-pohuehue	Straggling prostrate shrub.	River-bed; stony ground in tussock-grassland.
——— ——— x axillaris . . .		Various forms intermediate or connecting the two species.	Where the two parents occur in close proximity.
Chenopodiaceae.			
Rhagodia nutans R. Br. . . .	Red sea-berry	Much-branched, slender semi-wooded drooping plant.	Coastal shingle-cliff.
Chenopodium glaucum L. var ambiguum (R.Br.) Hook. f.	Coastal-goosefoot	Prostrate much-branched herb.	Salt-meadow.
Atriplex Buchanani T. Kirk . . .	Grey-orache	Mat-forming semi-woody plant.	Coastal shingle-cliff.
Salicornia australis Sol. ex Forst. f. . .	Austral-glasswort	Succulent, semi-prostrate, apparently leafless semi-woody plant.	Salt-swamp; salt-meadow.
Suaeda maritima (L.) Dum. . . .	Sea-blite	Succulent, much-branched, semi-woody plant.	Salt-swamp; salt-meadow.
Aizoceae.			
Tetragonia expansa Murr. . . .	New Zealand spinach	Semi-erect, far-spreading succulent herb.	Coastal shingle-cliff.
Portulacaceae.			
Claytonia australasica Hook. f. . . .	Austral spring-beauty	Low, far-spreading, turf-making herb.	Summit of coastal shingle-cliff (stony ground).
Montia fontana L.	Water-chickweed	Very slender herb forming dense masses.	Shallow water.
Caryophyllaceae.			
Stellaria parviflora Banks et Sol. ex Hook. f.	Little-chickweed	Slender, creeping mat-forming herb.	Forest.
——— elatinoides Hook. f. . . .	Small-leaved chickweed	Slender creeping or suberect herb.	Tussock-grassland.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	COMMUNITIES, Etc.	LIFE-FORM.	POPULAR NAME.
Colobanthus crassifolius (D'Urv.) Hook. f.	Common-colobanth	Very small, grassy rosette-herb.	Tussock-grassland.
——— Muelleri T. Kirk	Shore-colobanth	Very small, rigid, rosette-herb.	Coastal shingle-cliff
Scleranthus biflorus (Forst. f.) Hook. f.	Yellow-pincushion	Small cushion-plant.	Tussock - grassland; coastal shingle-cliff; river-bed.
Spergularia media (L.) Presl.	Salt-spurrey	Prostrate, succulent, viscid herb.	Salt-meadow.
Ranunculaceae.			
Clematis indivisia Willd.	White-clematis	Tendril liane.	Forest.
——— marata J. B. Armstg.	Brown-clematis	Low, entangled tendril liane.	Usually climbing Discaria of tussock-grassland, river-bed and ancient dune.
——— afoliata Buch.	Leafless clematis	Liane, but forming entangled masses of rush-like stems.	Stony ground, but I have not the exact locality, etc.
Myosurus novae-zelandiae W. R. B. Oliver	New Zealand mouse-tail	Very small annual herb.	Tussock-grassland.
Ranunculus hirtus Banks et Sol.	Hairy-buttercup	Low, slender, hairy herb.	Open forest.
——— multiscapus Hook. f.	Grassland-buttercup	Small, open-rosette herb.	Tussock-grassland.
——— macropus Hook. f.	Swamp-buttercup	Herb with floating leaves.	Shallow water; swamp
——— rivularis Banks et Sol. ex Forst. f.	Water-buttercup	Herb with much-cut, floating leaves.	shallow water; swamp.
——— ——— var glareosus Ckn. et Allan	Shingle-buttercup	Far-spreading, slender, creeping herb.	Coastal shingle-terrace.
——— acaulis Banks et Sol. ex DC.	Shore-buttercup	Very low, tiny rosette-herb.	Dune-hollow.
Winteraceae.			
Wintera colorata (Raoul) Ckn.	Red-horopito	Medium-sized or tall shrub.	Forest.
Cruciferae.			
Nasturtium palustre DC.	Hanea	Small, slender leafy herb.	Damp ground in tussock-grassland.
Lepidium tenuicaule T. Kirk	Shore-cress	Slender, procumbent herb.	Coastal shingle-cliff and consolidated stony beach.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
Cardamine heterophylla (Forst. f.) O. E. Schulz	Panapana	Small, slender, erect, leafy herb.	Forest.
Droseraceae.			
Drosera spathulata Lab. . . . . (Formerly in bogs, but probably extinct on the Plain.)	Spoon-leaved sun-dew	Small rosette-herb.	Bog.
Crassulaceae.			
Tillaea Sinclairii Hook. f. . . .	Water-tillaea	Minute, mat-herb.	Wet ground.
——— Sieberiana Schultz . . .	False-stonecrop	Small, reddish, succulent herb.	River-bed; stony ground in tussock-grassland.
Saxifragaceae.			
Carpodetus serratus Forst. . . .	Putaputawheta	Small, bushy tree.	Forest.
Pittosporaceae.			
Pittosporum tenuifolium Banks et Sol. ex Gaertn.	Common-pittosporum	Small, bushy tree.	Forest.
——— eugenioides A. Cunn. . . .	Tarata	Small, bushy tree.	Forest.
Rosaceae.			
Rubus australis Forst. f. var. glaber Hook. f.	Lawyer	High-climbing scrambler.	Forest.
——— cissoides A. Cunn. . . . (In full sunshine has no leaf-blades, only prickly midribs.)	Yellow-prickled lawyer	High-climbing scrambler.	Forest; river-terrace.
——— subpauperatus Ckn. . . .	Red-prickled lawyer	High-climbing scrambler.	Forest; river-terrace; coastal shingle-terrace.
Geum magellanicum Comm. ex Pers. . .	Southern-avens	Medium-sized, erect herb.	Forest (in open ground but not in primitive association).
Potentilla anserina L. var. anserinoides Raoul .	Silverweed	Far-spreading, creeping herb.	Wet ground.
Acaena novae-zelandiae T. Kirk . .	Red-burr	Thick mat-forming semi-woody plant.	Tussock-grassland; dune hollow.
——— Sanguisorbae Vahl var. pusilla Bitter .	Common piripiri	Thick mat-forming semi-woody plant.	Tussock-grassland.
———x novae-zelandiae . . .		Thick mat-forming, semi-woody plant.	Tussock-grassland.
——— inermis Hook. f. . . .	Spineless piripiri	Mat-forming semi-woody plant.	River-bed.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
——— microphylla Hook. f.	Red piripiri	Mat-forming semi-woody plant.	River-bed.
——— ——— x inermis		Mat-forming semi-woody plants.	River-bed.
Leguminosae.			
Carmichaelia nana Col. ex Hook.	Dwarf-broom	Far-spreading, very low, leafless shrub.	Stony ground in tussock-grassland.
——— Monroi Hook. f.	Stout dwarf-broom	Low, leafless shrub.	River-bed.
——— subulata T. Kirk	Common New Zealand broom	Medium-sized, erect, leafless shrub.	River-bed; dune hollow; tussock-grassland; coastal shingle terrace.
——— diffusa Petrie	Slender-broom	Small, erect, leafless shrub.	Tussock-grassland.
——— gracilis J. B. Armstg.	climbing-broom	Scrambling liane.	Swamp.
——— juncea Col. ex Hook. f.	Rush-like broom	Small, slender, leafless shrub.	Tussock-grassland.
Edwardsia microphylla Salisb.	Kowhai	Small, deciduous tree.	River-bed; tussock-grassland.
Geraniaceae.			
Geranium sessiliflorum Cav. var. glabrum Kunth (and 1 or more other vars.)	Southern-cranesbill	Rosette-forming semi-woody plant.	Tussock - grassland; shingle beach.
——— microphyllum Hook. f.	Prostrate-cranesbill	Straggling, prostrate herb.	Bog; tussock-grassland.
Pelargonium inodorum Willd.	Kopata	Small, erect herb.	Tussock-grassland.
Oxalidaceae.			
Oxalis corniculata L.	Yellow-oxalis	Spreading, prostrate herb.	Tussock-grassland.
Linaceae.			
Linum monogynum Forst. f.	White-flax	Medium-sized, erect, semi-woody plant.	Shingle beach; dune; coastal shingle-cliff.
Rutaceae.			
Melicope simplex A. Cunn.	Poataniwha	Tall, divaricating shrub.	Forest.
Euphorbiaceae.			
Euphorbia glauca Forst. f.	Sand-spurge	Tall, sand-binding herb.	Dune.
Callitrichaceae.			
Callitriche verna L.	Water-starwort	Slender, floating herb.	Shallow water.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
Stackhousiaceae.			
Stackhousia minima Hook. f.	Honey-sweet	Minute, creeping matted herb.	Tussock-grassland.
Coriariaceae.			
Coriaria sarmentosa Forst. f.	Tutu	Tall, summergreen, semi-woody plant.	River-bed; tussock-grassland.
——— lurida T. Kirk	Thymy-tutu	Medium-sized, erect, summergreen herb.	Tussock-grassland.
Icacinaceae.			
Pennantia cormybosa Forst.	Kaikomako	Small tree with divaricating juvenile form.	Forest.
Rhamnaceae.			
Pomaderris phylicaefolia Lodd.	Heath-pomaderris	Small heath-like shrub.	Leptospermum shrubland.
Discaria toumatou Raoul	Wild-irishman	Semi-divaricating spiny shrub.	River-bed; dune hollow; tussock-grassland.
Elaeocarpaceae.			
Elaeocarpus dentatus Vahl.	Hinau	Medium-sized tree.	Forest.
——— Hookerianus Raoul	Pokaka	Small tree with divaricating juvenile form.	Forest.
Aristotelia serrata (A. Cunn.) W. R. B. Oliver	Wineberry	Small more or less deciduous tree.	Forest.
Malvaceae.			
Plagianthus divaricatus Forst.	Shrubby-ribbonwood	Ball-like, divaricating, almost deciduous shrub.	Salt-swamp; salt-meadow.
Hoheria angustifolia Raoul	Narrow-leaved lace-bark	Small tree with divaricating juvenile form.	Forest.
Guttiferae.			
Hypericum gramineum Forst. f.	Southern St. John's wort	Small, erect semi-woody plant.	Tussock-grassland.
——— japonicum Thunb	Japanese St. John's wort	Small, procumbent herb.	Tussock-grassland.
Elatinaceae.			
Elatine gratioloides A. Cunn.	Water-wort	Minute herb making patches.	Wet ground.
Violaceae.			
Viola Cunninghamii Hook f.	New Zealand violet	Loose rosette-herb.	Tussock-grassland; bog.
Melicytus ramiflorus Forst.	Mahoe	Small bushy-tree.	Forest.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
Hymenanthera crassifolia Hook. f.	Coast porcupine shrub	Low, rigid divaricating shrub.	Coastal shingle-cliff.
Passifloraceae.			
Tetrapathaea tetrandra (Banks et Sol. ex DC.) Cheesem.	Glossy passion-flower	Tendril-liane.	Forest.
Thymelaeaceae.			
Pimelea arenaria A. Cunn.	Sand-pimelea	Sand-collecting twiggy-shrub.	Dune.
——— prostrata Willd.	Common pimelea	Small prostrate shrub.	Tussock - grassland; river-bed.
Myrtaceae.			
Leptospermum scoparium Forst.	Manuka	Tall, slender shrub.	Manuka shrubland; dune - hollow; tussock-grassland.
——— ——— form with crimson flowers (more than one has been seen on the Plain, and a garden seedling from one of these is L. Nicholsii.)	Crimson-Manuka	Slender, somewhat drooping shrub.	Originally near Chaney's Corner on stable dune.
Metrosideros hypericifolia A. Cunn.	Common rata-vine	Root-climbing liane.	Forest.
Myrtus obcordata (Raoul) Hook. f.	Rohutu	Large bushy-shrub or small tree.	Forest.
——— pedunculata Hook. f.	Slender-myrtle	Medium-sized twiggy-shrub.	Forest.
Onagraceae.			
Epilobium pallidiflorum Sol. ex A. Cunn.	Swamp-willowherb	Tall semi-woody plant.	Swamp.
——— Billardierianum Ser.	Red-stemmed-willow-herb	Tall semi-woody plant.	Dune-hollow; sandy ground near sea.
——— junceum Sol. ex Spring.	Narrow-leaved-willowherb	Medium-sized semi-woody plant.	Dune hollow; tussock grassland; riverbed.
——— pubens A. Rich	Hairy-willowherb	Medium-sized semi-woody plant.	Forest; tussock-grassland.
——— pictum Petrie	Variegated-willow-herb	Small, erect herb.	Now in forest, but hardly belongs to the original association.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
Epilobium Hectori Hausskn.		Small, erect herb.	Tussock - grassland; river-bed.
——— insulare Hausskn.	Marsh-willowherb	Small, creeping herb.	Swamp.
——— rotundifolium Forst. f.	Forest-willowherb	Erect or semi-prostrate, medium sized herb.	Forest.
——— nummularifolium R. Cunn. ex A. Cunn.	Creeping-willowherb	Mat-forming herb.	Tussock-grassland.
——— pedunculare A. Cunn. var. brunnescens Ckn.	Brownish-willowherb	Mat-forming herb.	River-bed; coastal shingle-cliff; tussock-grassland.
——— ——— var. minutiflorum		Mat-forming herb.	River-bed.
——— nerterioides A. Cunn.	Wrinkled-willowherb	Mat-forming herb.	River-bed; tussock-grassland.
——— melanocaulon Hook. var. typicum Ckn. et Allan	Black-stemmed-willowherb	Erect, semi-woody plant.	River-bed.
——— microphyllum A. Rich	Papakoura	Erect, semi-woody plant.	River-bed; coastal shingle-cliff.
——— erectum Petrie	Giant-willowherb	Tall, semi-woody plant.	Swamp.
——— novae-zelandiae Hausskn.	Pale-willowherb	Prostrate herb.	Tussock-grassland.
Fuchsia excorticata (Forst.) Linn. f.	Tree-fuchsia	Small, but massive tree.	Forest.
——— Colensoi Hook. f.	Shrub-fuchsia	Twiggy shrub.	Forest.
——— ——— x excorticata		Twiggy shrub.	Forest.
Halorrhagaceae.			
Halorrhagis erecta (Murr.) Schindler	Tall-haloragis	Tall, branching, semi-woody plant.	Tussock-grassland.
——— depressa Walp.	Mat-haloragis	Mat-forming, creeping semi-woody plant.	Tussock-grassland.
——— micrantha R. Br.	Bog-haloragis	Much-creeping herb.	Bog.
Myriophyllum elatinoides Gaud.	Water-milfoil	Erect aquatic herb.	Streams.
——— propinquum A. Cunn.	Austral-milfoil	Erect aquatic herb.	Streams.
Gunnera arenaria Cheesem.	Sand-gunnera	Large, circular mat plant.	Wet-dune-hollows.
——— monoica Raoul (may not be this species).		Creeping mat-plant.	Margin of swamp (rare).
Araliaceae.			
Nothopanax arboreum (Forst. f.) Seem.	Ivy-tree	Small, round-headed tree.	Forest.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
Pseudopanax crassifolium Sol. ex A. Cunn. var. unifoliolatum T. Kirk	Lancewood	Small, round-headed tree.	Forest.
Umbelliferae.			
Hydrocotyle americana L.	American marsh-pennywort	Mat-forming herb.	Forest.
——— tripartita R. Br. ex A. Rich	Swamp marsh-penny wort	Mat-forming herb.	Swamp; wet ground.
——— novae-zelandiae DC.	New Zealand marsh pennywort	Mat-forming herb.	Tussock-grassland.
——— moschata Forst. f.	Hispid-marsh-penny-wort	Mat-forming herb.	Tussock-grassland.
Centella uniflora (Col.) Nannf.	Asian marsh-penny-wort	Small creeping herb.	Wet ground.
Eryngium vesiculosum Lab.	Austral sea-holly	Rosette-herb with runners.	Salt-meadow; summit of coastal-shingle-cliff.
Oreomyrrhis andicola Endl. (in a very wide sense).	Mountain-myrrh	Low, tufted herb.	Tussock-grassland.
Lilaeopsis Bidwillii A. W. Hill	Common-crantzia	Small, creeping rushlike herb.	Shallow water; dune-hollow.
Apium prostratum Lab.	Wild-celery	Suberect or prostrate herb.	Salt-meadow; coastal shingle-cliff.
——— filiforme Hook.	Slender-celery	Slender prostrate or semi-prostrate herb.	Salt-meadow.
——— ——— x prostratum		Many forms combining the character of the parents.	Salt-meadow.
Aciphylla squarrosa Forst (A compound species with but one variety defined as yet.)	Speargrass	Tall, erect rosette-plant with stiff sharp-pointed leaves.	Tussock-grassland.
Anisotome aromatica Hook. f.	Kopoti	Low stemless herb with spreading leaves.	Tussock-grassland.
Angelica montana (Forst. f.) Ckn.	Aniseed	Rather tall, aromatic herb.	Tussock - grassland; (originally abundant, now almost wanting.)
Daucus brachiatus Sieb.	Wild-carrot	Small erect annual or biennial herb.	Tussock-grassland.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
Cornaceae.			
Griselinia littoralis Raoul	Broadleaf	Small tree.	Forest.
Epacridaceae.			
Leucopogon Fraseri A. Cunn.	Dwarf-heath	Low creeping shrub.	Dune-hollow; tussock-grassland.
Cyathodes acerosa R. Br.	Taumingi	Small shrub with very short pungent leaves.	Leptospermum shrub-land.
Dracophyllum Urvilleanum (or some other species) A. Rich.	Wharekohu	Erect shrub with grass-like leaves.	Bog (now extinct on the Plain).
Myrsinaceae.			
Suttonia australis A. Rich.	Mapau	Small bushy-tree.	Forest.
Primulaceae.			
Samolus repens (Forst.) Pers. var. procumbens R. Knuth	Southern water-pimpernel	Creeping low semi-woody plant.	Salt-meadow.
Gentianaceae.			
Gentiana novae-zelandiae J. B. Armstg.	Dwarf-gentian	Small, depressed herb.	Tussock-grassland.
Apocynaceae.			
Parsonsia heterophylla A. Cunn.	Kaihua	Slender, winding liane.	Forest.
——— capsularis R. Br. var. rosea (Raoul) Ckn.	Pink-kaihua	Slender, winding liane.	Forest.
Convolvulaceae.			
Calystegia Soldanella (L.) R. Br.	Sand-convolvulus	Prostrate, sand-binding herb.	Dune; shingle beach.
Convolvulus erubescens Sims	Blush-convolvulus	Slender, creeping herb.	Tussock - grassland; summit of coastal shingle-cliff.
Dichondra repens Forst.	Dichondra	Patch-making, creeping herb.	Tussock-grassland.
——— brevifolia Buch.		Patch-making, creeping herb.	Tussock-grassland.
Boraginaceae.			
Myosotis pygmaea Col. (A compound species, badly-understood, consisting of many distinct jordanons, between which are probably hybrids in abundance.)	Pigmy forget-me-not	Small, prostrate herb.	Tussock-grassland.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
Labiatae.			
Mentha Cunninghamii Benth.	New Zealand mint	Small, prostrate herb.	Tussock-grassland.
Solanaceae.			
Solanum nigrum L. (The New Zealand plant probably is an unnamed endemic species and S. nigrum L. is an introduced species.)	Black nightshade	Fairly tall, semi-woody plant.	Forest, but not in the primitive community.
——— aviculare Forst. f.	Poroporo	Tall, shrublike, semi-woody plant.	Forest.
Scrophulariaceae.			
Mimulus repens R.Br.	Coast-musk	Creeping, rather succulent herb.	Streams, etc., in salt-meadow.
Mazus pumilio R.Br.	False-musk	Small, creeping herb.	Moist dune-hollow.
Gratiola peruviana L.	Herb-of-Grace	Semi-erect water-herb.	Swamp.
Glossostigma elatinoides Benth. ex Hook. f.	Water-moss	Prostrate moss-like water-herb.	Swamp.
Limosella tenuifolia Nutt	Mudwort	Small, creeping, patch-making waterherb.	Swamp.
Hebe salicifolia (Forst. f.) Pennell var. communis (Ckn.) Ckn. et Allan	Willow-koromiko	Tall shrub.	Swamp.
——— Raoulii (Hook. f.) Ckn. et Allan	Pink koromiko	Dwarf semi-erect shrub.	River-bed (only recorded from bed of R. Selwyn).
Lentibulariaceae.			
Utricularia novae-zelandiae Hook. f.	New Zealand bladderwort	Slender herb, furnished with tiny "bladders."	Shallow water.
——— monanthos Hook. f.	Purple-bladderwort	Slender herb, furnished with tiny "bladders."	Bog; shallow water.
Myoporaceae.			
Myoporum laetum Forst. f.	Ngaio	Small, round-headed tree.	Forest.
Plantaginaceae.			
Plantago Raoulii Dcne.	Common-plantain	Herb with erect rosettes.	Tussock-grassland.
Plantago spathulata Hook. f.	Grassland-plantain	Herb with flat rosettes.	Tussock-grassland of higher parts of Plain; coastal shingle-cliff.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
Rubiaceae.			
Coprosma robusta Raoul . . .	Karamu	Tall, leafy shrub.	
——— propinqua A. Cunn. . . .	Common-karamu	Medium-sized shrub.	Forest; swamp (at present).
——— prorobusta Ckn. et Allen (C. propinqua x robusta, all its form taken together.) .		Medium-sized shrubs of many forms and drupes of many colours.	Forest (at present). Swamp.
——— areolata Cheesem. . . .	Thin-leaved karamu	Large shrub.	Forest.
——— rotundifolia A. Cunn. . .	Round-leaved karamu	Tall shrub.	Forest.
——— rhamnoides A. Cunn. . .	Wiry-karamu	Divaricating-shrub.	Forest.
——— crassifolia Col. . . .	Stiff-stemmed karamu	Divaricating-shrub.	Forest.
——— rugosa Cheesem. . . .	Heath-karamu	Divaricating-shrub.	
——— acerosa A. Cunn. . . .	Sand-karamu	Divaricating shrub.	Dune.
——— brunnea (T. Kirk) Ckn. . .	Jewel-karamu	Prostrate shrub.	River-bed.
——— Petriei Cheesem. . . .	Turf-karamu	Turf-making shrub.	Tussock-grassland.
Nertera setulosa Hook. f. . . .	Hispid-nertera	Low creeping herb.	Tussock-grassland.
Galium umbrosum Sol. ex Forst. f. . .	New Zealand bedstraw	Small, semi-erect herb.	Damp ground in shade.
——— tenuicaule A. Cunn. . . .	Straggling bedstraw	Slender, straggling herb.	Damp ground in shade
Campanulaceae.			
Pratia angulata Hook. f. . . .	Creeping-pratia	Far-creeping herb.	Tussock-grassland in moist ground.
Wahlenbergia gracilis (Forst. f.) Hook. f. . (A compound species demanding intensive study in the field.)	Slender bluebell	Erect semi-woody-plant.	Tussock-grassland.
——— albomarginata Hook. . . .	Mountain-bluebell	Small rosette-herb.	Tussock-grassland of higher part of Plain.
Goodeniaceae.			
Selliera radicans Cav.	Selliera	Turf-making herb.	Salt-meadow; coastal shingle-cliff.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
Compositae.			
Lagenophora petiolata Hook. f.	Parani	Creeping rosette-herb.	Tussock-grassland.
——— cuneata Petrie		Creeping rosette-herb.	Tussock-grassland.
Brachycome Sinclairii Hook. f.	Grassland-daisy	Creeping turf-forming herb.	Tussock-grassland.
——— pinnata Hook. f. (probably crosses with other species)		Creeping turf-forming herb.	Tussock - grassland; summit of coastal shingle-cliff.
Olearia virgata Hook. f.	Swamp tree-daisy	Slender divaricating shrub.	Swamp.
Celmisia gracilenta Hook. f.	Pekepeke	Small, tufted herb.	Tussock-grassland.
Vittadinia australis A. Rich.	Southern vittadinia	Small, erect semi-woody plant.	Tussock-grassland.
Gnaphalium luteo-album L.	Flannel-leaf	Erect, woolly herb.	Tussock - grassland; river-bed; dune.
——— japonicum Thunb.	Japan-cudweed	Small, erect, semi-woody plant.	Tussock - grassland; river-bed; dune-hollow.
——— collinum Lab.	Austral-cudweed	Erect, creeping herb.	Tussock-grassland.
Raoulia lutescens T. Kirk Beauv.	Scabweed	Low cushion-plant.	River-bed; coastal shingle-terrace.
——— australis Hook. f. (A compound species made up of several unnamed varieties).	Silvery-raoulia	Mat-forming semi-woody plant.	River-bed.
——— Monroi Hook. f.		Patch-forming semi-woody plant.	River - bed; stony ground in tussock-grassland; coastal shingle-terrace.
——— tenuicaulis Hook. f.	Mat-raoulia	Moss-like, green, mat plant.	River-bed.
Helichrysum filicaule Hook. f.	Slender-everlasting	Low, erect, creeping herb.	Tussock - grassland; river-bed.
Cassinia fulvida Hook. f.	Golden-tauhinu	Small, ericoid shrub.	River-bed.
Craspedia uniflora Forst. f. (A linneon made up of other species and hybrids between them.)	Craspedia	Flat or semi-erect rosette-herb.	Tussock-grassland.

LIST OF SPECIES, TOGETHER WITH POPULAR NAMES, LIFE-FORMS, AND COMMUNITIES TO WHICH THEY BELONG.—Continued.

NAME OF SPECIES, FAMILY, ETC.	POPULAR NAME.	LIFE-FORM.	COMMUNITIES, Etc.
Cotula coronopifolia L.	Yellow-button	Suberect far-spreading creeping plant.	Salt-meadow; shallow water.
——— maniototo Petrie		Small patch-forming herb.	River-bed in moist ground.
——— filiformis Hook. f.	Slender-cotula	Creeping, patch-forming herb.	Tussock-grassland.
——— Haastii T. Kirk.		Turf-forming herb.	Tussock-grassland.
——— perpusilla Hook. f.	Silky-cotula	Turf-forming herb.	River-bed, tussock-grassland.
——— squalida Hook. f.	Fern-cotula	Turf-forming herb.	Tussock - grassland; (rare).
——— dioica Hook. f.	Shore-cotula	Turf-making herb.	Salt-meadow.
Centipeda orbicularis Lour.		Small, suberect, annual herb.	Salt-meadow.
Erechtites prenanthoides (A. Rich.) DC.	Common fireweed	Tall, biennial semi-woody plant.	Forest.
——— quadridentata (Lab.)	White fireweed	Tall, semi-woody plant.	Dune-hollow.
——— arguta (A. Rich.) DC.	Woolly fireweed	Tall, semi-woody plant.	Dune-hollow.
Senecio bellidioides Hook. f.	New Zealand groundsel	Low, rosette-herb.	Tussock-grassland.
——— lautus Forst. f.	Shore-groundsel	Erect, branching herb.	Coastal shingle terrace.
Microseris scapigera (Forst. f.) O. Hoffm.		Low, rosette-herb.	Tussock-grassland.

Alpine and Sub-Alpine Flora.

By A. Wall, M.A.

The Alps of Canterbury, occupying as they do the central portion of the main ranges of the South Island Alpine chain, are representative in respect of their flora of this mountain mass as a whole; they afford typical examples of dry shingly slopes, heavily forested areas, precipitous rocks both damp and dry, lofty rocky peaks like Malte Brun, and grasslands of widely varying composition. Very few types of alpine vegetation are here altogether unrepresented; there are, however, no mountains like the characteristic Otago schist ranges, such as the Old Man or Rock and Pillar, whose tops are peaty plateaux; nor like those of the Nelson ranges bordering the Pelorus and Lower Wairau Rivers, such as Mts. Richmond and Fishtail, whose summits are mere islets in an ocean of forest; nor like those of the South-West Sounds, such as the Sheerdown Range in Milford Sound, and all these offer species which Canterbury knows not. On the other hand Canterbury boasts the highest peaks of all and here she possesses some few plants elsewhere unknown; and the strange caprices of natural distribution have awarded to her, especially in certain areas of limestone, a good share of rare species which, so far as we know at present, are exclusively her own.

The alpine and subalpine vegetation adds greatly to the beauty of the Canterbury Alps—the tawny grassland, the sombre deep-blue pelt of the forest, the dense subalpine scrub with its varying shades of olive, brown and green, relieved in the due season by the white masses of the Great Mountain Buttercup, and the herbfield extending to five or even six thousand feet, with its vast wealth of brilliant Celmisias, Buttercups, and other beautiful flowers. The most impressive features of the scene, especially near the Divide and in the neighbourhood of Mt. Cook, are of course the great snow-fields and glaciers to whose beauty the plant can contribute nothing. But even here a close

view reveals plant-life, often beautiful, always interesting, in the most unlikely and apparently hopeless situations. The fine Myosotis Traversii makes a home among the débris of the living glacier, adorning with its white sweet-scented flowers the precipitous margins of the trough wherein the ice moves, and wherever a ridge of steep rock shows among the snow-fields, up to an altitude of seven or eight thousand feet, plants will be found—sometimes a small Gentian (probably *G. divisa)* as on the Glacier Dome close to the summits of Mt. Cook; sometimes the cosmopolitan alpine grass, *Trisetum subspicatum*; sometimes the pretty fern *Blechnum penna marina;* sometimes a beautiful *Myosotis.* On the bare and rather forbidding rocky ridges of the Eastern Alps (and even, where conditions are suitable, as on the Mt. Cook Range, close to the Western Divide), grows the marvellous "Vegetable Sheep" *(Raoulia eximia),* whose huge rounded, pale white masses are visible from a great distance. The individual plant is sometimes as much as six feet in diameter and three feet high, as hard as the rock itself, and presenting to the blast of the Nor'-West gale a smooth surface of densely compacted "wool," the leaves being completely masked by the long whitish hairs which clothe them and project beyond their tips to form this wonderful felt.

Very close to the snow-line and often within a few feet of the terminal of a hanging glacier appears the splendid Buttercup, *Ranunculus Godleyanus,* and in similar situations, up to 6000 feet or more, the smaller but still more beautiful *Ranunculus sericophyllus.* On the steep faces of Malte Brun overlooking the Tasman Glacier Graham's Buttercup, *Ranunculus Grahami,* ascends to 9,500 feet, apparently without any special adaptation, and produces a fine upstanding yellow bloom.

Owing to the central position of Canterbury as regards a "North and South" distribution its flora is very typical of the Southern Alps as a whole, and the great majority of its plants and plant-associations are such as will generally be found elsewhere, especially along the eastern side of the whole great range which forms the backbone of the South Island. This flora might be most correctly described as Eastern Central.

The Main Divide is everywhere a very clear botanic frontier, separating two widely differing types of vegetation. The majestic rain-forest of Westland, with its tall trees of many sorts, and its great wealth of filmy ferns and other epiphytes; the rain-loving shrubs such as *Olearia Colensoi,* and the strange-looking, broad-leaved Tree Dracophylla, are almost entirely absent from Canterbury. A great deal of nor'-west rain, however, falls on the main Divide, and its rain-laden gusts generally sweep down the main valleys of the eastern slope for several miles before finally parting with their load of moisture. There are, therefore, quite a number of plants which flourish at a distance of from five to ten miles from the Divide, yet cannot live in the truly dry climate of the extreme Eastern Alps, such as that of Mounts Hutt, Torlesse and Puketeraki. This class includes those two noble kinsmen, *Ranunculus Lyallii* and *Ranunculus Godleyanus; Ranunculus sericophyllus, Veronica Gilliesiana, Coprosma serrulata, Celmisia petiolata,* and *Celmisia glandulosa.* Most of these occur on the Rangitata down to the Lawrence, on the Rakaia to the Wilberforce, and on the Waimakariri to the Hawdon or North Branch, but very little further east.

The plants of the New Zealand mountains are nearly all peculiar to this country, and this is not surprising, since these ranges stand so far aloof from all others. Our mountain flowers are for the most part our own pride and glory. Thus all the Veronicas, Senecios, Olearias and Forget-Me-Nots, and all the Buttercups but one in our list are found nowhere else, though these great groups are, of course, represented by other species in other lands. The entire genus *Celmisia,* with the exception of a solitary species *(Celmisia longifolia),* found also in Australia and Tasmania, is confined to New Zealand, *Raoulia* is in the same position, while the genus *Haastia* is quite unrepresented elsewhere.

There are, however, some very remarkable exceptions to this general rule. The two Fescues *(Festuca novæ zelandiæ* and F. *rubra)* are almost world-wide in their distribution, though the former is now regarded rather as a distinct species than a variety of Red Fescue, of

which Chewing's Fescue is a well-known form. The small *Carex pyrenaica,* which takes its name from the Pyrenees, occurs on high mountains throughout Europe, in North America and Japan, and both the North and South Islands of New Zealand. The Sweet Woodrush of the Old Land, *Luzula campestris,* is almost a citizen of the world, and is recognised in New Zealand in four varieties, of which one, var. *migrata,* is not unlike the common English form. The alpine grass, *Trisetum subspicatum,* which is common at high altitudes in the Southern Alps, occurs generally in the high mountains of both hemispheres. The common Silver Tussock *(Poa cæspitosa)* grows also in Australia and Tasmania; *Danthonia semi-annularis* in Australia; Holy Grass *(Hierochloe redolens)* in Fuegia, Tasmania and Victoria. The extremely variable *Oreomyrrhis andicola,* of which three very different varieties are recognised in New Zealand, is found, as its name implies, in the Andes, and it occurs in Australia and Tasmania.

The nearest mountains to ours are those of Australia, the highest of which are over 7000 feet high and about 1200 miles distant from us. A fair number of alpine and subalpine species are common to the Australian Alps and the Mount Cook district. At about 5000 feet the following species, which are also found in New Zealand, are recorded in the Australian Alps:—*Poa cæspitosa, Luzula campestris, Scleranthus biflorus, Pentachondra pumila, Leucopogon Fraseri, Nertera depressa, Celmisia longifolia, Erechtities quadridentata, Microseris Forsteri* and a few ferns. Most of these grow in New Zealand at much lower elevations owing to the difference in climate, and, in fact, all but one or two flourish with us from sea-level to about 3000 or 4000 feet; none of them would be considered as typically alpine, hardly even as subalpine plants. Several of our typical genera, however, are represented by different species from ours in these Australian Alps, such as *Danthonia, Pimelea, Aciphylla Craspedia, Olearia, Raoulia* and *Helichrysum,* and these point to a rather remoter affinity and a longer period of isolation. It is really but a very minute proportion of the mountain flora of New Zealand that may be said to coincide exactly with that of Australia.

The writer calculates that of the alpine plants of Canterbury 85 per cent. are confined to New Zealand, about 10 per cent being common to New Zealand and Australia, while the remaining 5 per cent. are of more or less world-wide distribution.

Present Surface-Forms.

The dissection and reduction of the main Central Range produced an infinite variety of surface-forms: sharp rocky ridges; precipitous faces, sometimes stable, and, humanly speaking, permanent, sometimes comparatively loose and crumbling; glaciated cwms and high basins, more or less filled up with rough detritus and often holding shallow lakes or tarns; broad high spurs, narrower high spurs, slopes on the flanks of ridges and spurs ranging from nearly precipitous to comparatively level, and offering very different facings to the sun; broad flat glaciated river-valleys; narrow stream-cut gullies; moraines new and old; peat-bogs; tarn-margins and edges of small high-rising streams; valleys deep and sheltered enough to permit of the growth of forest-trees; and vast areas of shingle and morainic material carried down by glaciers and thrown open for settlement as soon as the glacier retreats. Hence we have a correspondingly great variety of types of vegetation more or less specially adapted to life in these widely differing habitats.

History Summarised.

The flora of the Alps of Canterbury as we see it where it is as yet undisturbed and undestroyed, happily still a great tract of country, represents the flora of the ancient New Zealand Continent with its alien acclimatised invaders from Australia and Antarctica, after long ages of isolated development and the throwing up of multitudinous new species, new genera, and even a few new orders, subjected to very varied and sometimes extremely exacting conditions, and finally through a very long period by a kind of trying out process, undergoing very many minor climatic changes and redistributions as it followed the changing face of the slowly crumbling and vanishing range—some species disappearing, some becoming exceedingly rare, some

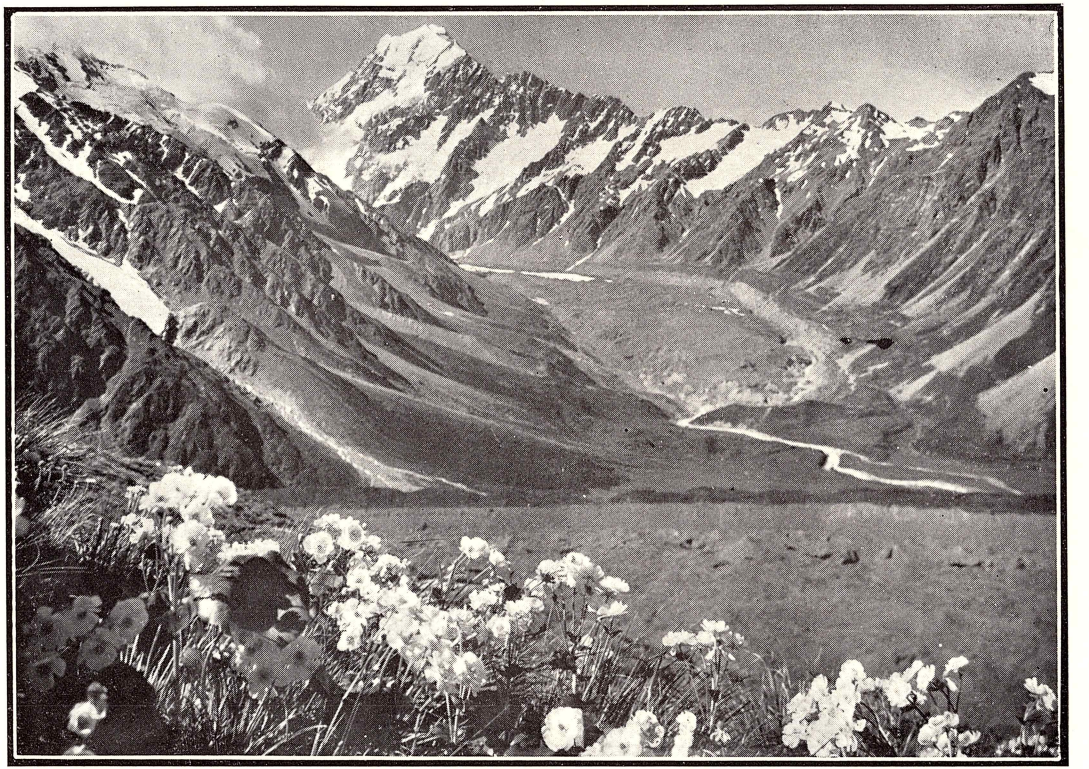
triumphantly spreading and becoming ubiquitous, and some still newly developing, whether under the stress of changing conditions or by hybridisation or by the sheer creative impulse of nature—called Mutation.

Adaptations.

It was long ago proved by Diels and Cockayne that many of the plants of New Zealand show clear signs of adaptation to a very rigorous semi-desert climate such as is conjectured to have obtained in late Tertiary times, especially on the eastern side of the Canterbury Alps. The story of this wind-scourged and drought-stricken period is written in the numerous shrubs which have become leafless, such as the Carmichaelias (Brooms) and allied genera, the leafless Lawyer and Clematis; and the Wild Irishman. Some of these become leafy under favourable circumstances and Cockayne in his classic experiments showed that these plants as a group retain still the power of producing leaves if they are subjected from germination to moist conditions. Leaf reduction is also illustrated in the well-known Whipcord Veronicas. Here the leaves become very small, and are so closely compacted and appressed to the stem as to produce the curious appearance from which the group is popularly named. The same arrangement is seen in *Helichrysum Selago* and some other species of this genus.

The shingle-plants are better represented in the Alps of Canterbury, upon such mountains as Hutt, Torlesse and Puketeraki, than anywhere else. In order to check excessive transpiration and maintain their tissues in their natural state of tension, some plants of very high altitudes become "woolly" or "hairy," such as the famous Vegetable Sheep and allied species; the tiny *Veronica pulvinaris;* the Alpine variety of *Craspedia uniflora*; the beautiful Graham's Veronica; "Edelweiss" and some species of *Celmisia.* Others merely become smaller in size as they mount and others again show a gradual approximation of the leaves to one another, and finally these reach a stage of imbrication which even suggests the whipcord arrangement. *Veronica Haastii,* which flourishes from 6000 to over 9000 feet, exhibits no other adaptation than this.

Many plants adopt the cushion or mat-form which



Mt. Cook, with Ranunculus Lyallii in foreground. [Photo, C. Beken.

perfectly fits them to sustain any amount of wind-pressure, the most violent gusts merely flowing over them like water. Of this kind are the Raoulias as a group; *Helichrysum Youngii;* the Phyllachnes; *Veronica pulvinaris* and *V. ciliolata; Hectorella cæspitosa* and *Colobanthus acicularis.*

Whilst nature demands of these plants the special adaptations she permits others to flourish under the same conditions with little or no perceptible protection. No precautions, so far as we can see, have been adopted by, e.g., *Pratia macrodon, Schizeilima Haastii* and *Senecio scorzoneroides,* nor by the high alpine grass *Poa novæ zelandiæ,* though this last is very much smaller at 7000 feet than it is at 3000 feet, and so small on shingle slips as to have achieved varietal rank (var. *Wallii).*

The general character and appearance of the alpine and still more, perhaps, of the subalpine flora of the high alps of Canterbury is thus seen to result from the extremely rigorous conditions which were imposed upon it in the remote past, and these still subsist, though in a less extreme degree, and continue to act upon it.

The Plant Communities.

The plants of the Canterbury Alps, as of any other Alpine district, fall naturally into groups of communities according to the altitudinal and other conditions under which they grow. One group, of course, may readily shade off into another; no hard and fast lines can readily be drawn round each one, for nature does not lay out her gardens by rule and square. Some are, however, very rigidly specialised, the "shingle-plants," e.g., form a perfectly distinctive group and hardly one of them is ever found in any other locality than a true "scree" or "shingle-slip." So it is with the bog-plants.

Some plants occur, as might be expected, in more than one group; some are almost ubiquitous. Some species, often spoken of as "plastic," readily accommodate themselves to widely different conditions and are therefore found in varying form in different associations. It is indeed sometimes very difficult to fix the definitions of certain species and varieties on account of this tendency to variation in response to environment. *Oreomyrrhis andicola, Cardamine hirsuta,* and

Pimelea prostrata may be mentioned among the alpine and subalpine plants of Canterbury, the last two being common from sea level to 6000 or even 7000 feet in very widely differing situations.

Here follow the clearest groups or associations with examples of representative localities, and of the leading characteristic species of each.

Tussock Grass Land.—Shingle or detritus lying bare after the retreat of glaciers or the shifting of rivers is colonised first by certain herbs, grasses or mat plants, and becomes in time the characteristic grassland diversified with Wild-Irishman scrub which occupies the Mackenzie and Canterbury Plains in their original state. All stages of this development occur on the beds of the great snow-rivers of Canterbury and by the moraines, but the Grassland as we now see it is much modified everywhere by grazing and burning, and many exotic weeds have intruded into it. Characteristic plants: *Poa caespitosa*; *Poa Colensoi; Poa intermedia; Festuca novæ-zelandiæ; Craspedia uniflora; Cotula squalida; Hydrocotyle novæ-zelandiæ; Helichrysum filicaule; Geranium microphyllum; Raoulia glabra; Muehlenbeckia axillaris; Pimelea prostrata;* different varieties of *Luzula campestris.*

Open Shrubland.—Patches and clumps of isolated shrubs alternate with areas of tussock grassland, or shingly creek-beds. Characteristic shrubs are:—*Dacrydium Bidwillii; Podocarpus nivalis; Senecio cassinioides; Discaria Toumatou; Aristotelia fruticosa; Coprosma rugosa; C. propinqua, C. parviflora; Corokia Cotoneaster; Veronica Traversii; Dracophyllum longifolium; D. uniflorum; Olearia moschata; O. nummularifolia; Cassinia fulvida.*

Sub-Alpine Scrub.—Mountain shrubs make a close formation, often exceedingly thick and almost impenetrable, from about 2500 to over 4000 feet. The floor of the scrub harbours many herbs and some grasses and ferns.

The characteristic plants are: *Phyllocladus alpinus; Dracophyllum uniflorum; Podocarpus nivalis; Senecio cassinioides; S. elaeagnifolius; Olearia moschata; O. nummularifolia; Veronica Traversii; V. leiophylla; Coprosma cuneata; C. serrulata; C. ramulosa; Gaya ribifolia; Panax Colensoi* (reduced form); *Hymenan-*

thera dentata var. alpina; Carmichaelia grandiflora; Gaultheria rupestris; Phormium tenax. Plants of the floor are—*Ranunculus Lyallii; Anisotome Haastii; Aciphylla Colensoi; Senecio Haastii; Celmisia coriacea; C. petiolata; C. Walkeri; Viola Cunninghamii; Pratia angulata; Ranunculus hirtus; Taraxacum magellanicum; SenecioLyallii; Corysanthes triloba; Helichrysum bellidioides; Poa Colensoi; Danthonia flavescens.* Ferns and their allies are represented by *Hymenophyllum villosum; Blechnum penna marina; Polystichum vestitum; Lycopodium fastigiatum; L. varium.*

This scrub presents the appearance of a level-topped sheet of greenish-brown vegetation varying from the pale green of *Senecio cassinioides* and the sage green of *Gaya ribifolia* to the reddish olive tints of *Podocarpus nivalis* and *Dracophyllum uniflorum.* The *Phyllocladus* stands out conspicuously above the other shrubs, its elasticity making it a most efficient wind-resister. In the proper season, November-December, the rather sombre face of the scrub is lightened and diversified by the large white masses of *Ranunculus Lyallii* and *Anisotome Haastii.*

The dominant plant of the scrub is usually *Phyllocladus alpinus* (while the Mountain Totara is a very important constituent) up to about 4000 feet, where these usually give place to a herb-field or alpine grassland, especially the great Snowgrass, *Danthonia flavescens;* at 5000 feet this grass is often the dominant plant.

Mountain Bog-plants—Boggy and peaty hollows and the margins of shallow pools or tarns support a vegetation peculiarly their own. Characteristic plants —*Oreobolus pumilio; Carpha alpina; Caltha novæ zelandiæ; Celmisia glandulosa; Drosera Arcturi; Carex Gaudichaudiana; C. stellulata; Ranunculus gracilipes; Schoenus pauciflorus; Plantago Brownii; Herpolirion novæ-zelandiæ.*

Plants of River and Creek-beds, Shingle-fans and Margins of Moraine.—Detritus brought down by rivers, creeks, glaciers, or falling from steep slopes and forming fans along the margins of flat river-valleys is colonised rapidly by various herbs and grasses. The ground here is in an intermediate state between com-

plete barrenness and either grassland or scrub, and is occupied by a well-defined group of plants. Characteristic plants—*Epilobium melanocaulon; E. microphyllum; Muehlenbeckia axillaris; Blechnum penna marina; Luzula campestris* (various forms); *Luzula racemosa,* var. *Traversii; Poa Lindsayi, Helichrysum depressum; Raoulia australis; R. tenuicaulis; R. Haastii; Myosotis uniflora; Stellaria gracilenta; Coriaria thymifolia.* Usually at a rather later stage come *Poa Colensoi; Danthonia setifolia; Wahlenbergia albomarginata; Geranium sessiliflorum var. glabrum; Poa novæ-zelandiæ; Epilobium tenuipes; Myosotis Traversii* (on moraine); *Discaria Toumatou.*

Naturally there are very numerous variations possible; all these will hardly be found in any one locality. In some situations the first colonist to make good is *Helichrysum depressum;* in others *Raoulia australis* or *R. Haastii;* in others, *Coriaria thymifolia;* in others again *Muehlenbeckia axillaris,* but in nearly every case the first plants on the ground are *Epilobium melanocaulon* and *Poa Lindsayi;* these, however, make no turf or soil and do not serve to bind the material.

Shingle-plants.—Running shingle or detritus on the Eastern Canterbury Alps overlies, on steep slopes, a clayey soil in which grow certain most peculiar plants with remarkable adaptations to their strange habitat. They are of an ashen-grey colour with a tendency in some cases towards pale glaucous blue *(Ranunculus Haastii);* their roots are exceedingly thick and long and extend up-hill from the plant; their leaves and stems are fleshy and act as store-houses for the water upon which their life depends. They harmonise so perfectly with the stones among which they grow that it is often difficult to see them, especially when they are not in flower. The true shingle-plants are never found in any other situation than this, and hardly any other plants can grow there. One intruder, however, the English Sheep's Sorrel *(Rumex acetosella),* often abounds in the shingle. The most important plants of this group are *Ranunculus Haastii, Stellaria Roughii, Anisotome carnosula, Mysotis Traversii,* and *Cotula atrata.* The very rare *Ranunculus crithmifolius* belongs to the tribe and has been recorded in one locality in Canterbury by R. M. Laing—on the Spurs of Mt.

Celmisia coriacea. [Photo, C. Beken.

Arrowsmith. The pretty *Epilobium pycnostachyum* has much of the character of these plants but can flourish in other situations. The members of this strange association nearly always grow far apart; they never approach one another so as to form any sort of sward or continuous sheet of vegetation; their effect upon the landscape is thus quite negligible. It may be added that they usually all die down in winter and that sheep and deer, though they frequent the shingle-slips and make innumerable tracks upon them, seldom or never eat these plants. One grass, *Poa sclerophylla*, grows abundantly in the shingle and nowhere else, and has some of the peculiar habit of the shingle-plants.

Alpine Fell-field or Grassland.—This is the usual covering of the mountain flanks from 4000 to about 6000 feet and consists of very various and often beautiful herbs, small shrubs and grasses. It takes its prevailing colour and appearance in the Mount Cook district from the vast numbers of tussocks of the giant Snowgrass. It forms the usual vegetation above the scrub on parts of the Sealy Range, the flanks of the Malte Brun Range above the Tasman Glacier and of the Mount Cook Range from Mount Kinsey to Wakefield; also about the Hooker Hut, though often alternating with scrub.

Characteristic plants of (a) the Fell-field of Wakefield Ridge on the northern side, overlooking the Tasman Glacier at 5000 feet—a rather bare and stony type which is both grazed and burnt—include.—*Poa Colensoi; Agrostis Muelleri; Danthonia flavescens; D. crassiuscula; Luzula campestris* (two varieties); *Veronica Buchanani; Pimelea prostrata; Drapetes Dieffenbachii; Carex Wakatipu; Anisotome aromatica; Celmisia Walkeri; C. Lyallii; C. Haastii; C. discolor; C. sessiliflora; C. laricifolia.*

Plants of the Fell-field of (b) the slopes on the western side of the Hooker Glacier near the Stocking Glacier include—*Celmisia petiolata; C. discolor* (and allied forms); *C. Lyallii; C. Walkeri; Veronica Gilliesiana; V. macrantha; Brachycome Sinclairii; Aciphylla Monroi; Anisotome pilifera; A. Haastii; Senecio scorzoneroides; Ourisia caespitosa; Myrsine mummularia; Gentiana corymbifera; Astelia nervosa* var. *montana; Caltha novæ-zelandiæ; Euphrasia revoluta; Forstera*

sedifolia; Coprosma cuneata; C. repens; Danthonia flavescens; Poa Colensoi; Carmichaelia grandiflora and reduced forms of *Podocarpus nivalis;* and *Dracophyllum uniflorum.*

The Fell-field (c) above the Mueller Glacier at 5000 feet facing north (above the Green Rock) includes all the plants in the above list, and the following are also noted there—*Drapetes Dieffenbachii; Cotula pyrethrifolia; Erechtites glabrescens; Pratia macrodon; Deyeuxia avenoides; Deyeuxia Forsteri* var. *pilosa; Craspedia uniflora; Epilobium chloraefolium; Aciphylla Lyallii; Pimelea prostrata; Coprosma serrulata; Uncinia compacta.*

The Fell-field (d) about the Sefton Bivouac, from 5000 feet to 5500 feet, yielded the following list—*Drapetes Lyalli; Celmisia sessiliflora; C. Hectori; C. linearis; C. petiolata*; *C. Lyallii; Luzula pumila; Poa Colensoi; Danthonia flavescens* (much reduced); *Anisotome aromatica* (very small); *A. pilfera; Raoulia grandiflora; Rostkovia gracilis; Senecio Lyallii; Phyllachne Colensoi; Veronica pulvinaris*; *V. monticola* (?); *V. Gilliesiana; Gaultheria rupestris* (much reduced and possibly *G. antipoda* var. *depressa)*; *Ourisia sessilifolia; Euphrasia revoluta; Dracophyllum Kirkii; Coprosma cuneata; C. repens; Colobanthus acicularis; Schizeilima Haastii;* a *Celmisia* of the *C. Sinclairii* group difficult to place; *Celmisia Haastii;* and *Gentiana corymbifera.*

(e) Fell-field of the Upper Waimakariri (represented by the unnamed mountain which flanks the Hawdon River or North Branch on its eastern side) at 5000 to 6000 feet includes—*Veronica Gilliesiana, Ranunculus Lyallii. Geum uniflorum, Dracophyllum Kirkii, Celmisia petiolata, C. linearis, Ehrharta Colensoi, Danthonia crassiuscula,* and on the western side of the same river, besides the above-mentioned plants—*Danthonia flavescens, Poa Colensoi, Veronica buxifolia, V. epacridea, V. lycopodioides, Coprosma cuneata, Senecio Lyallii, Ourisia sessiliflora, O. caespitosa, Raoulia grandiflora, Celmisia incana, C. spectabilis, C. laricifolia* and *Pentachondra pumila.*

These five lists are fairly representative of the constitutents of this association in the Southern Alps as a whole.

High Alpine Plants.—The combined action of high winds and deep snows determines at high elevations the characteristic forms of plants inhabiting plateaux or the fairly level tops of high spurs from 5000 about 7000 feet. Many of these plants assume the mat or cushion form, with very short branches, stems thickly tufted and leaves closely compacted together. The spurs leading from the Tasman Glacier to the Mount Cook Range, and especially that leading to the Ball Pass, form excellent localities of this type, offering a fairly broad ridge as the summit of the spur. Characteristic plants—(a) of the Ball Spur, 5000 feet to 7000 feet—*Ranunculus sericophyllus; Colobanthus acicularis; Hectorella caespitosa; Anisotome imbricata; Epilobium tasmanicum; Celmisia Hectori; C. sessiliflora; C. discolor; C. Haastii; C. Lyallii; C. Poppelwellii* (or new species?); *Helichrysum Youngii; Senecio scorzoneroides; Raoulia eximia; R. subulata; R. grandiflora; Phyllachne Colensoi; Pimelea laevigata; Myosotis Traversii; Veronica Haastii; V. pulvinaris; V. Gilliesiana; Hymenanthera dentata* var. *alpina; Dracophyllum rosmarinifolium; Drapetes Lyallii; Luzula pumila; Carex pyrenaica; Danthonia crassiuscula; Poa sclerophylla; P. novæ-zelandiæ; Polystichum cystostegium.*

(b) Of Malte Brun, 6500 feet to over 9000 feet—*Ranunculus Grahami; Colobanthus acicularis; Cardamine Ensyii; Epilobium tasmanicum; Anisotome imbricata, Schizeilima Haastii, Raoulia eximia; R. grandiflora; Helichrysum Youngii; Cotula pyrethrifolia; Senecio scorzoneroides; Phyllachne Colensoi; Pratia macrodon; Dracophyllum Kirkii; Myosotis suavis; M. Traversii* (?); *Veronica Haastii; V. Grahami; V. Pulvinaris; Luzula pumila; Poa novæ-zelandiæ; P. sclerophylla; Blechnum penna marinum.* Three of these reach 9000 feet and even higher:—*Ranunculus Grahami; Veronica Grahami* and *Veronica Haastii.*

(c) Of Sealy Range (Kitchener Ridge), 5000 feet to *7000 feet:—Veronica Grahami; V. Haastii; V. Gilliesiana; Celmisia Hectori; Ranunculus sericophyllus; Hectorella caespitosa; Raoulia grandiflora; Phyllachne Colensoi; Drapetes Lyallii; Rostkovia gracilis; Luzula*

pumila; Poa novæ-zelandiæ; Senecio scorzoneroides; Anisotome imbricata.

(d) Of Haast Ridge from Memorial Hut to Glacier Dome, 7000 feet to 8000 feet—*Veronica Haastii; V. Gilliesiana; Helichrysum Youngii; Poa novæ-zelandiæ; Gentiana,* possibly *G. divisa,* on the highest rocks close to Glacier Dome at nearly 8000 feet.

Plants of Loose Débris and Rocky Ridges.—The basins below very high ridges, the faces of such ridges, and the narrow level portions of the ridges themselves support a sparse vegetation of alpine species. Characteristic plants—of the looser debris—*Haastia Sinclairii, Veronica Gilliesiana, Dracophyllum Kirkii, Veronica Haastii.* Of the ridge—*Helichrysum Youngii, Pimelea prostrata, Veronica Haastii, Poa sclerophylla, Poa novæ-zelandiæ.* Naturally there can be no hard and fast line between these last two classes.

Plants of High Basins and Sources of Streams.—About the head waters of high-rising streams damp and even boggy ground occurs harbouring many plants, mostly very small, which usually form a close harsh turf at from 4500 feet to 6500 feet, a number of them being minute grasses and sedges. Characteristic plants—*Ranunculus gracilipes, Carex pyrenaica, Poa Colensoi* (in much reduced forms), *Luzula pumila, Drapetes Lyallii, Caltha novæ-zelandiæ, Scirpus aucklandicus.*

Plants of Cliffs and Precipices up to 9000 Feet.—Upon the faces and within the chimneys, cracks and chasms of solid precipitous rocks grow many species which prefer these to all other situations. Those growing in the cracks and chasms are called chasmophytes. Cliffs at low elevations supporting typical plants are those of Sebastopol; the best examples of the high cliffs are those on Malte Brun and Aiguille Rouge. Characteristic plants:—

(a) Of the Higher Elevations.—On the cliffs and precipices of the Malte Brun Range from 6500 to 8000 feet occur—*Ranunculus Grahami, Colobanthus acicularis, Cardamine Enysii, Epilobium tasmanicum, Schizeilima Haastii, Raoulia eximia, Helichrysum Youngii, Cotula pyrethrifolia, Senecio scorzoneroides, Drycophyllum Kirkii, Myosotis suavis, Myosotis*

Traversii (?), Veronica Haastii, V. Grahami, Poa novæ-zelandiæ, Blechnum penna marinum.

(b) Of the Lower Elevations (dry).—*Helichrysum grandiceps* ("Edelweiss"), *Helichrysum Selago, Exocarpus Bidwillii.*

(c) Of Wet Cliffs.—The truly characteristic species are *Veronica linifolia* and *Celmisia bellidioides,* which grow hardly anywhere else. Others generally present are *Poa novæ-zelandiæ* (large pendent form), *Schoenus pauciflorus, Senecio Lyallii* and *S. scorzoneroides, Veronica Lyallii, Olearia arborescens, Polypodium australe.*

Plants of Very Loose Unstable Rocks, Knobs and Faces.—Many species take hold rapidly and become abundant in rock faces and on unstable knobs which are liable to perpetual change. Very many are destroyed, as rocks are continually falling, but certain species seem able to maintain themselves in such places in spite of all risks. Localities of this kind are on the Sealy Range, spurs coming down to The Hermitage on the north-eastern faces; the Haast Ridge is also a good typical example. Characteristic plants—*Veronica Gilliesiana, Veronica Haastii, Helichrysum Youngii, Poa novæ-zelandiæ, Celmisia Hectori.*

Lichens, Mosses and Ferns of Canterbury.

H. H. Allan, D.Sc.

A most important section of botanical study is that of the distribution of the plants of a country or of a district, and hand in hand with this goes a study of their ecology and taxonomy.

As a result of what has been accomplished L. Cockayne has been enabled to delimit the Botanical Districts of this country. The Province of Canterbury is found to include the southern portion of the north-eastern South Island Botanical District, the whole of the Eastern, and a Northern inlier of the North Otago District, and thus offers to workers in it splendid opportunities for the more exact study of the boundaries of these districts. In this connection the study of the ferns, mosses and lichens is of considerable importance, but it must be added that only in the case of the ferns have we anything like sufficient knowledge either of the species or of their distribution.

Interest in the ferns has indeed been more or less maintained throughout, but for the others work has been spasmodic, and interrupted by long intervals. We have failed to follow the splendid example set us by the earlier investigators, and as a result there are such grave lacunæ in our knowledge that ecological and distributional work is seriously hampered. This is still more true of other groups of lower plants. Thus in the desmids Maskell did excellent work from 1881 to 1883, but it has never been followed up; in the liverworts only a little casual collecting has been done, and our knowledge remains exiguous.

1. The Earlier Collectors and Explorers. 1840-1868.

The first recorded work of importance is that of Raoul, enshrined in his *Choix de Plantes de la Nouvelle-Zélande,* 1846. Besides listing the species hitherto

found in New Zealand, he gives descriptions of certain mosses and ferns found by him on Banks Peninsula. Then come the names of those great botanical explorers Haast, Sinclair, Lyall and Travers. These assiduous collectors gathered freely ferns and mosses, many of them from our area, and their material was of the greatest service to Hooker in working up the New Zealand Flora. Certain also of Joliffe's collections were made in Canterbury, and we are reminded of his work by the moss *Hypnum Joliffii.* Plant after plant recalls the services of the previous four, while their collections are fully recorded in the pages of Hooker's *Handbook to the New Zealand Flora,* 1864-7. The frequent occurrence of their names as collectors in many localities is a permanent reminder of their activities and the debt we owe to them for throwing a flood of light upon the distribution of species. The services towards the advancement of general botanical knowledge in the province will be properly commemorated elsewhere in this volume, but one cannot leave such a name as that of Haast, without an expression of admiration and wonder at the zealous and enthusiastic way in which, in the midst of multifarious duties, he seized every opportunity to further the cause of botanical science.

The lichens of the province, however, still displayed their charms unavailingly—their time of appreciation was not yet.

2. The Earlier Contributors to the "Transactions of the New Zealand Institute," 1869-1884.

With the appearance of the *Transactions* was opened up to local workers an avenue for the display of their own observations at first hand. In the earlier period the names of J. F. Armstrong, J. D. Enys, T. H. Potts and J. B. Armstrong stand out prominently. In 1870 J. F. Armstrong published a list of the species occurring in the neighbourhood of Christchurch, enumerating 36 ferns, 11 mosses and 4 lichens. In 1874 T. Kirk records the occurrence of *Cheilanthes tenuifolia* on rocks at Lyttelton, thus confirming the earlier discovery of this fern by Lyall, possibly on the same spot. Enys published a paper on the nomenclature of ferns, and in 1884 recorded the occurrence on Mount Torlesse of *Botrychium lunaria,* a fern of wide distribution, but

which has not again be found at Mount Torlesse, or anywhere else in New Zealand. Potts helped to enlarge our knowledge of the distribution of the ferns of the province. In 1880 J. B. Armstrong published his important paper, *A Short Sketch of the Flora of the Province of Canterbury.* In this he lists 109 ferns, 214 mosses and 95 lichens. Unfortunately for neither of the two latter groups does he give localities, or the authority for the identifications. In the following year he published a paper on *A Natural Arrangement of the New Zealand Ferns,* which includes critical notes on certain of the ferns found in the province.

In this period, too, Potts published in *The New Zealand Country Journal* a series of articles entitled *Fern Leaves,* including various observations on the natural history of ferns, and some provincial localities in which they occur. Later, 1882, his notes were embodied in the well-known little classic, *Out in the Open.* In this year J. B. Armstrong considerably helped to arouse interest in the study of ferns by a series of articles in the *Canterbury Times.* Thus the period saw satisfactory progress with the ferns, but little concerning the other groups.

3. The Period of Intensive Study, 1893-1899.

From 1884 to 1893 there was a lull, at any rate as far as published results are concerned, though more or less haphazard collecting continued. In 1893 a new period commences, for in this year R. Brown published in the *Transactions* the first of a long series of detailed papers giving the results of his devoted study of the mosses. The last paper of the series appeared in 1903. The mosses of Canterbury come in for considerable attention. In the introduction to the first paper he remarks, "the following account of the genus *Andreaea* as it occurs in New Zealand is a portion of the results of ten years' work, studying and collecting the *Musci* of New Zealand in their native habitats, and figuring in various species and varieties with the camera lucida."

Concerning his work Mr. H. N. Dixon remarks " that the botanical work of a man of such enthusiasm, so true a lover of nature's works, so indefatigable and unsparing of himself in their pursuit, should stand in

Foliaceous Lichens, Peel Forest.

danger of being lost to science would be deplorable." This danger, a very real one, has now been averted by the labours of Mr. Dixon, and the true value of his achievements can be assessed and recognised.

In the same volume, also, of the *Transactions* T. W. N. Beckett commenced a series of important studies of mosses, partly based on material from Canterbury. And in 1898 the lichens first received any adequate treatment, beyond what had been accomplished by Babbington for Hooker's *Flora Novæ-Zélandiæ*, at the hands of J. Stirton. Thus was commenced, though unfortunately not followed up, the necessary intensive study of species which must precede further advances.

4. The Era of Ecological Study, 1900-1926.

Although it will be clear from what has been said that ecological work on mosses and lichens was hardly yet possible, some attention was given to them during the period now ensuing, and at least the need for their study became gradually more clearly recognised. The period opened with the now classical paper of Cockayne, *A Sketch of the Plant Geography of the Waimakariri River Basin,* in the *Transactions* for 1900, although in this the groups we are concerned with received but little attention. There followed in 1911 Cockayne and Laing's account of the vegetation of the Mount Arrowsmith district, in which 22 ferns and lycopods are listed, and some ecological details are given. In 1916 Cockayne and Foweraker, dealing with the plant-association near the Canterbury College Mountain Biological Station at Cass, give ecological notes of the ferns, of which they list 13.

In this period, too, Holloway, in his very important studies of the New Zealand lycopods and of the life-history of *Tmesipteris tannensis,* makes use of material and observations derived from Canterbury, and in his paper of 1919 on the "plasticity" of the species of *Lycopodium* gives valuable ecological data. In 1919 appeared Laing's useful paper on *The Vegetation of Banks Peninsula,* in which 75 ferns are listed, with critical comments. This was supplemented in 1924 by a further paper by Laing and Wall. Miss Herriott published in 1919 an interesting *History of Hagley Park,* in which appears J. B. Armstrong's list of the

plants occurring in the Park in 1864, which includes 7 ferns. These are not now to be found there. In 1926 Allan published an account of the *Vegetation of Mount Peel,* in which the ferns occurring in the different associations are referred to, the total number of ferns and fern-allies present being given as 61.

Some attention was also paid in this period to general distribution, and several published lists give localities in Canterbury for certain ferns. Cockayne in 1906 included 19 ferns in his list of plants occurring in Riccarton Bush, and in 1919 gave, on the authority of H. N. Dixon, a list of localities, some for Canterbury, of mosses, adding valuable details as to habitats. W. Martin (1920) gives a list of the ferns of the eastern portion of Banks Peninsula, and in 1921 some further records for the Eastern Botanical District. In 1925, in an appendix to Dr. J. P. Lotsy's *Evolution Considered in the Light of Hybridization,* Cockayne gives a list of supposed wild New Zealand hybrids, in which are included 13 groups of fern-hybrids, some of which are known to occur in Canterbury.

5. Recent Popular Accounts.

In this connection Professor Arnold Wall has done yeoman service. In 1922 in the *Lyttelton Times* he gave an interesting series of articles, subsequently published in pamphlet form, on the botany of the Riccarton Bush. He lists 16 ferns. He has also published an account of *The Botany of Christchurch,* in which the ferns receive considerable attention. There are listed for Christchurch and neighbourhood 55 ferns and fern-allies, with statements as to habitats. Finally there is his little pamphlet, written with gusto, *Ferns of the Port Hills,* invaluable for local collectors, and picturing in miniature the ardency of his explorations. Dr. C. Chilton has also edited an account of Riccarton Bush, which appeared in 1924, and which lists the 16 ferns present.

6. The Canterbury Museum Herbarium.

The museum herbarium is the natural repository for specimens representing the flora of the Province, as well as having wider aims. The collection should

therefore be made as full and representative as possible. Indeed, one would expect to find in its sheets a reflection of the history of botanical progress in Canterbury, and evidence of the state to which our knowledge has reached. As it exists at present the herbarium has a fairly good collection of the ferns, including some of the important earlier gatherings; and thanks to the zealous care of the Honorary Keeper, Professor A. Wall, the specimens are in good order and arrangement, and furnish a satisfactory basis for further work. There remains much to be done, however, before the collection can be said to represent in anything like detail the distribution of the species throughout the province, or the diversity of forms to be found amongst the species.

If this be true of the ferns, what can be said of the mosses and lichens? We have seen that work on these groups has lagged behind, and this is further revealed by an examination of the herbarium material. Of lichens there is a valuable collection of about 90 specimens presented by T. W. N. Beckett, which contains some of Stirton's types, and that is all. Opportunity is being taken of the presence in New Zealand, as this is being written, of Dr. G. Einar Du Rietz the distinguished Swedish lichenologist to have these worked over. A number of specimens collected in Canterbury by the writer are already in the hands of this authority, and will be added to the Museum when his examination of them is completed. That many important results are bound to come to light when lichens receive proper attention from New Zealand workers is instanced by the fact that in the collection just mentioned occur *Cetraria islandica* var. *tenuifolia* and *Solorina crocea,* gathered on Mount Peel, but not hitherto known to occur in New Zealand. Obviously there is a vast amount to be done. The mosses of the herbarium are in still worse case—there are none from Canterbury proper! Here then is a virgin field. Now that the critical examination of Brown's herbarium, and other material by Mr. H. N. Dixon has enabled him to publish his *Studies in the Bryology of New Zealand* as a special bulletin of the New Zealand Institute there is every incentive for New Zealand workers to include the mosses in their purview.

7. The Outlook.

There are not wanting signs that ecologists will not long remain content with stopping at the ferns. As stated early on it is now realized that mosses, lichens, liverworts and fungi are of equal importance with the so-called "higher" plants, and have equally important lessons to teach—economic no less than "purely scientific." There is, then, greatly to be desired and encouraged a revival of general interest in, and active collection of mosses and lichens, let alone other groups. Enthusiasts are needed to collect carefuly and thoroughly from particular localities, and to send duly annotated specimens to the Museum herbarium, so that they may be forwarded where necessary, to those able and willing to identify and arrange them.

Inability to name specimens is no real handicap to the collector—power to name will come as his experience accumulates. What is needed is a correct account of the association from which the specimens come, and their particular growing-places, forest-floor amongst moss, rotten log, rough trunk of tree at a certain altitude and so on. Fortunately both mosses and lichens are easy to collect and preserve. They may be placed, as collected, into old envelopes open at each end, and allowed to dry in a cool airy place. Later on a soaking in water is the most that is necessary to render them in good condition for examination. The present writer would be more than pleased to render any assistance he could by accepting duplicates for preparation and transmission to the various authorities, and finally forwarding them to the herbarium for preservation.

Zoology of Canterbury.

GENERAL INTRODUCTION.

By Chas. Chilton, Professor of Biology, Canterbury College.

The Province of Canterbury as originally defined was bounded on the north by the river Hurunui, on the south by the Waitaki, on the east by the sea, while on the west it was separated from the neighbouring Province of Westland by the mountain range of the Southern Alps. But natural history knows no such narrow limits. It is not surprising therefore that the animal inhabitants are not confined to Canterbury but extend beyond its boundaries, some in one direction, some in another, according to their several means of dispersal. From the point of view of its zoology, Canterbury is a part of New Zealand and possesses no marked features of its own.

Though New Zealand as a whole possesses great diversity of surface and climate compared with its total extent, and this is reflected in its plant covering and to a less extent in the animals found in the different parts, Canterbury hardly shares in this diversity. The greater part consists of a huge plain sloping from the Southern Alps to the sea, crossed by numerous rivers issuing from mountain gorges and flowing over the plain in wide shingly river-beds, sometimes in flood but usually in a few shallow streams constantly changing their size and position. The plains are for the most part treeless, and the alluvial deposits of which they are formed are, or rather were, covered with monotonous tussock grass-lands with few swamps of any size. A small extent of swamp forest existed in the neighbourhood of Christchurch, extending as far as Papanui and, with a break, to Woodend beyond Kaiapoi. Manuka scrub formed patches in river beds and elsewhere, but otherwise scarcely altered the general character of the surface. The foot-hills and outliers of the mountain range were in places covered

with forests of the mountain beech, commonly known as "black birch" *(Nothofagus solandri),* and other trees, and the valleys further back among the mountains bore a more varied forest covering and thus offered shelters for animals that could not exist on the open plain. Banks Peninsula, the volcanic mass of hills interrupting the even sweep of the east coast, was originally covered with similar forest. Lake Ellesmere is a large shallow lake near the sea. Numerous mountain lakes, some of them of large size, are found among the mountains and provide homes for fish, water fowl and other aquatic forms of life. But these exceptions of mountains and lakes are hardly sufficient to alter the general sameness of the terrestrial fauna. The zoologist would find greater contrast between the animals on the dry plains and hills of Canterbury and those of the steeper slopes of Westland with its dense rain forests at a few miles distance than he would by traversing the whole of the Canterbury plain from the Hurunui to the Waitaki.

If we look at the marine fauna we find the same uniformity. The bays and inlets of Banks Peninsula give shelter to a considerable number of forms, but they are limited in extent and depth, and there is no large area of rocky sea bottom at shallow depth to support a great variety of marine animals. To the south of Banks Peninsula stretches for many miles a shingly beach singularly devoid of animal life, while the long sandy beach to the north offers little more variety.

But if the animals of Canterbury show little variety in the different parts of the province it is very different if we view them from the time aspect for the changes that have taken place since the European first appeared on the scene afford abundant openings for scientific research—research that should be most profitable in its bearing on general questions of evolution.

The Maoris and any predecessors they may have had produced little effect on the native fauna, though they brought with them the so-called Maori dog and Maori rat. Captain Cook liberated pigs and these soon became plentiful. What changes they brought about it is not now easy to say, but they are generally supposed to have helped in the extermination of the

Tuatara and other reptiles. The whalers and other early colonists unintentionally introduced the European rats and mice now to be found everywhere, and probably other smaller animals also, for two woodlice collected in New Zealand at an unknown date are named as new species in the British Museum List in 1847, though it is now known that they are European species that have been accidentally carried by man to all parts of the world. It is not likely that they came alone.

When the early colonists came to Canterbury about the middle of the nineteenth century they must have been astonished at the small number and the nature of the animals they found there and have marvelled at their unobtrusiveness. It is true there were birds in the bush, many of whom awakened the settlers with their melodious morning songs, sea-birds were abundant on the coast, and a few larks, hawks, ducks, and swamp-hens could be seen on the plain, while the wekas or wood-hens, and still more the strange kiwis, must have made the colonists wonder what animals they were, for these creatures could not fly but ran among the tussocks and shrubs just as a swift-running animal might do.

Other flightless birds were to be seen in the bush, but there was a strange absence of animals, that is, of quadrupeds,—no wild animals of any kind, carnivorous or herbivorous, to supply the explorer with sport or food, and, stranger still, there were no snakes, venomous or harmless, and very few lizards, and these only small and insignificant. The croak of the frog, familiar in the Home-land, was no longer heard, and the rivers supplied few fish except the eels and the fish-fry or whitebait, so abundant near the mouths of the streams in spring and early summer. This apparent absence of animal life was doubtless one of the factors that made the settlers so eager to introduce the birds and other animals from other lands which they desired to have with them for economic or sentimental reasons.

The story of the introduction of these birds and animals by the acclimatisation societies or by accident and their effect on the indigenous fauna will be told elsewhere. Frogs were brought in from Australia, and now the green climbing frog, *Hyla aurea,* is abundant

everywhere in the ponds and calmer waters of the streams. A brown whistling frog, *Hyla ewingii,* may be heard at certain places on the West Coast, and was probably accidentally introduced when ships came direct from Australia to Hokitika during the height of its prosperity due to the gold fields. The humble bee was, after several attempts, successfully introduced in 1885 to fertilise the red clover, and soon spread to all parts of the province.

These incomers flourished as new arrivals frequently do and helped to oust the native birds, insects, spiders and other lower forms, but in this they were assisted by another factor of greater importance—the cultivation of the soil. The tussock land was ploughed and sown down in English grass for the sheep or used for the growth of wheat, oats and other cereals. In other places where ploughing was not profitable or possible the land was pastured with sheep or cattle; in some cases the native bush or scrub was cut down and destroyed, in others, exotic trees were largely planted for shelter or for timber and firewood. The result has been that large areas of Canterbury have ceased to be New Zealand for the zoologist. He finds the animals—even the hedgehog—the birds, fish, earthworms, insects that he was accustomed to in other lands, but he looks in vain for the forms peculiar to New Zealand. For these he must get away from the cultivated fields and climb the hills or force his way into the untouched forest, and even then he will find the blackbird, thrush and starling instead of the tui and the bell-bird, and the introduced blowfly will annoy him more than the indigenous grasshopper would have done.

New Zealand is celebrated as the home of the wonderful and the unexpected and this is true of her animals as of her towering mountains, huge rivers, active volcanoes and boiling geysers. The early settlers of Canterbury who did not see much to marvel at in the animals on the plains, little knew that in some of the swamps there lay remains of gigantic birds that would soon attract the wonder and admiration of all. The earliest published notice of the existence of the moa appears to be by Polack in his *New Zealand* published in 1838, in which he says he is assured that

"a species of emu, or a bird of the genus *Struthio*" formerly existed in the North Island. The first moa bone seen in England was the shaft of a femur brought by Mr. Rule to Sir Richard Owen, who exhibited it to the Zoological Society on the 12th of November, 1839. Up to 1866 the Canterbury Museum possessed only a very few moa remains, chiefly from Nelson, but in December of that year large quantities of moa bones were discovered in the swamps on the Glenmark run in North Canterbury. These were eagerly gathered by Haast, the Director of the Canterbury Museum, and added to the collections which were then housed in the Provincial Buildings. Additional collections of great abundance and variety were afterwards made at Glenmark in 1868, and later on at other places in Canterbury. The moas were huge wingless birds closely allied to the existing kiwis, but they had all disappeared, having become extinct in quite recent times. The skeleton of *Dinornis maximus* in the Canterbury Museum collection is 10 feet 7 inches in height, that of *D. robustus* 9 feet 6 inches. Some of the other species though not so tall have more massive leg bones and there are others of much smaller size.

But moas were not the only large animals collected by Haast. While it is true, as stated above, that the fauna of the coast of Canterbury was scanty and inconspicuous, its long beaches were occasionally the scene of excitement owing to the stranding thereon of whales of different species from the surrounding seas. These were sought after by Haast as keenly as the moa skeletons and the Canterbury Museum was enriched with the spoil. Several skeletons of moderate sized whales had long been in the museum, but they were all eclipsed in 1908 by that of a huge Blue Whale, *Balaenoptera sibbaldii*, which was stranded on the Okarito Beach, Westland, and after considerable trouble and expense, secured and set up in the Museum by Mr. Edgar R. Waite. Its total length is 87 feet.

The existence of blind crustacea, "well shrimps," in the underground waters of the Canterbury Plains was announced by the writer in 1881. Five species are known, all of them occurring in the one well at Eyreton from which they were first obtained, and they are

known from several localities in the basin of the Waimakariri, and from Ashburton and Winchester. Other species are now known from other parts of New Zealand and Australia. One of them is an isopod, for which the genus *Phreatoicus* was established, and has become the type of a sub-order, the *Phreatoicidea,* containing several genera and many species from New Zealand, Australia and South Africa, while a fossil species has been described from the Triassic beds of New South Wales.

The Chatham Islands lie about 400 miles due east from Banks Peninsula and consist of one fairly large island and numerous islets and rocks. Politically they form part of the Lyttelton electorate, and biologically they are closely akin to Canterbury. Some of the animals are endemic but most of the birds, animals and plants belong to species known from the mainland of New Zealand or are different only as varieties. Several papers dealing with the birds and various of the groups of invertebrates from these islands have been published in recent numbers of the Canterbury Museum Records.

This general introduction cannot be closed without some mention of those workers who have made the zoology of Canterbury as fully known as it is. Fuller details of some of them are given in the biographical section, but those still active in Canterbury are for obvious reasons not given here. The first name that comes to mind is that of Julius von Haast, explorer, geologist, zoologist and museum director; large in bodily frame, broad in his sympathies and interests and untiring in energy he traversed the mountains and the plains in the 'sixties, crossed the rivers, observed the habits of the birds and made collections of animals and plants for that Museum which is his lasting memorial. Naturally he dealt specially with the larger vertebrates, the whales and dolphins and the birds, especially the remains of the moas. Next comes Captain F. W. Hutton, also both geologist and zoologist. He came to Canterbury much later, in 1880, and had to teach botany as well as zoology, but speedily founded a school of naturalists which is still active. He studied animals of all classes but devoted special attention to

the birds, the fish and, most of all, to the Mollusca. He was Curator of the Canterbury Museum from 1892 till his death in 1905.

Henry O. Forbes was Curator of the Museum during the interval between the death of Haast in 1887 and his resignation in 1892. During that time he collected fossil birds from the Chatham Islands and elsewhere and was led to consider the possible former extensions of the Antarctic Continent. Edgar R. Waite assumed charge of the Museum after the interregnum following Hutton's death and continued till in 1914 he was appointed to the South Australian Museum in Adelaide. He worked specially at the fishes and drew up a list of the New Zealand species.

This brief list completes the roll of the Museum Curators who may be considered Canterbury's official zoologists. The rest must be classed as amateurs and the result of their labours is another proof of the value of the amateur, the man who works for love and not because it is the duty of his position. T. H. Potts was a naturalist of the old type, now alas nearly extinct, a worker in the open, where he could observe the birds in whose habits he took such delight. Of entomologists there have been several enthusiastic collectors especially in the earlier days when insect life peculiar to New Zealand was more abundant on Canterbury's plains and hills.

Llewellyn Powell, the first Lecturer on Biology at Canterbury College was a keen observer and a skilled anatomist; he dealt with various animals and commenced an examination of the spiders but ill health and early death prevented its completion. Later came Arthur Dendy, Professor of Biology at Canterbury College from 1893 to 1902. His great work was tracing out the development of the Tuatara—work done in Canterbury though the material came from elsewhere —but he also worked out the terrestrial planarians or flat worms of the province and contributed to our knowledge of the New Zealand species of *Peripatus* and of other forms.

Henry Suter, the author of the *Manual of New Zealand Mollusca,* was employed at various times at the Auckland and Christchurch Museums and at the Dominion Museum in Wellington. During the latter

part of his life he resided in Christchurch. He was an indefatigable collector, and following Hutton, was the chief authority on the New Zealand Mollusca.

INVERTEBRATA.

By far the greater number of the invertebrate fauna of Canterbury belong to the Insecta and are dealt with in a separate article. Of the others few are conspicuous and the following brief notes of the different groups will probably be sufficient.

Crustacea. The largest freshwater form is the crayfish still to be found in most of the creeks and streams. It belongs to the genus *Paranephrops* which is peculiar to New Zealand. Three species are generally recognised, *P. planifrons* White, known as the North Island crayfish though it extends across Cook Strait through Nelson and down the West Coast even as far as Puysegur Point. The species found in the streams of the Canterbury Plains is *P. setosus* Hutton differing from *P. planifrons* in having shorter and more hairy chelipeds or great claws. *P. setosus* extends from North Canterbury as far south as Waimate though the specimens from some localities in that neighbourhood approach in character to the third species *P. zealandicus* White, which is found in most parts of Otago and also in Stewart Island, and comes nearer to *P. setosus* than to *P. planifrons.* Apparently the great mountain range of the Southern Alps and their extensions in the north towards the Kaikouras have acted as a barrier separating the area of distribution of *P. planifrons* from that of *P. setosus.* It is to be presumed that when New Zealand stood at a higher level before the formation of Cook Strait and extended further to the west *P. planifrons* existed in a larger river basin lying to the west and as the land rose was forced into the upper tributaries which now exist as the Wanganui, Buller, Grey, etc., while the other two species developed in river basins to the east separated from the first by the Southern Alps. *P. setosus* though common on the plains does not appear to extend into the mountain streams probably being prevented by the rapidity of the current and the coldness of these waters.

A small fresh water prawn, *Xiphocaris curvirostris* Heller, is found in the river Avon and other similar streams. It is common throughout New Zealand but does not extend very far from the sea. It grows to a length of about two inches and can be distinguished from the larger marine shrimp, *Leander affinis*, by the presence of small external branches or exopods on some of the thoracic legs. It is not known to occur in Australia where it is replaced by another species, *X. compressa*, but it appears again in Assam in south east Asia. It is frequently taken in tidal water along with the whitebait but its numbers are probably being lessened by the trout as are those of the crayfish, *Paranephrops setosus*. In all the streams of Canterbury and other parts of New Zealand a small amphipod, *Paracalliope fluviatilis* G. M. Thomson, is common on the water weeds. It is small, less than half an inch in length, and is usually dark in colour. It may be found in brackish and even in quite salt water and its distribution is interesting for it is found in suitable localities on the eastern coast of Bengal, e.g. in Chilka Lake, in the Phillipine Islands and on the eastern coast of Australia. Numerous water fleas, i.e. Copepoda, Cladocera, Ostracoda, are to be found in the ponds, lakes and streams. Of these the largest and most interesting is the Copepod *Boeckella triarticulata*. It is also found in Australia and belongs to a genus containing several species in South America, Falkland Islands and other subantarctic lands. *Lepidurus viridis*, a Phyllopod of dark green colour and from one to two inches in length, frequently occurs in the ponds in great numbers in early spring, disappearing as suddenly as it appears. It is found in Australia also.

Numerous Amphipods and Isopods occur on the sea shores. On the sandy beaches the large sandhopper, *Talorchestia quoyana* is common burrowing into the sand near high water mark or under masses of decaying kelp. Another species *T. telluris*, in which one of the joints of the last pair of legs is developed in the adult male into a huge expansion like a dish cover, is generally found burrowing into sand near the mouth of a river or stream. A third species *T. tumida* with greatly thickened body has not been recorded from Canterbury but is common on the east coast of

Otago and may extend further north. Several species of *Orchestia* also occur, the commonest being *O. chiliensis* usually found under stones on a rocky shore. This species is found also in South America and in the Juan Fernandez Islands where it ascends to a height of 1500 feet. In New Zealand it does not go very far from the coast but an allied form, *Parorchestia sylvicola* is truly terrestrial and is to be found under decaying leaves and logs in all parts even up to a height of 3000 feet or more.

Of the Isopoda many species of woodlice or slaters are to be found under leaves in the bush or under logs, etc., on the plains. The one commonest near the dwellings of men is *Porcellio scaber,* a European species which has been carried by man to all parts of the world. The commonest native species is the small *Cubaris rugulosus* which has the power of rolling itself into a compact ball when disturbed. On the sea-shore under rocks and stones is found the large *Ligia novaezealandiae,* which runs so rapidly that it is difficult to catch.

Of the more strictly marine forms of Crustacea little need be said. Numerous crabs are to be found, either on the mud flats, e.g., *Hemiplax hirtipes, Helice crassa* and *Heterograpsus crenulatus* or in the rock pools, e.g. *Paramithrax peronii,* which conceals its presence by encouraging a growth of seaweed, sponges, etc., on its carapace. Many other crabs are found near low water mark and of these may be mentioned *Cancer novaezealandiae* which is however seldom large enough to be useful as food like the European Cancer. The commonest "crab" in rockpools is *Petrolisthes elongatus* belonging to the "false crabs" or Anomura. The only species used for food are the rock crayfish *Jasus lalandii,* a species which is also found on the coasts of Cape Colony, South America and in other subantarctic seas, and the shrimp *Leander affinis.*

The subterranean Crustacea "Well Shrimps" found in the underground waters of the Canterbury Plains have already been referred to in the General Introduction.

MOLLUSCA.*

The Mollusca are much more numerous than might be expected by those who have not systematically hunted for them, for they are mostly small and inconspicuous, and of retiring habits. The large noble shell *Placostylus* of the North and various outlying islands is quite absent from Canterbury, and *Paryphanta* has been found in only a few localities. The only molluscs that make themselves at all conspicuous are the garden snail, *Helix aspersa* and various kinds of slugs, *Limax, Agriolimax, Amalia.* As might be expected with such "domesticated" animals, these have all been introduced, presumably from England, but some of them have spread along riverbeds, gullies, roads, and railways, even into sparsely-populated districts. Another introduced species must be mentioned—*Lymnaea stagnalis,* an inhabitant of rivers and streams; it is almost as large as a snail, but with a more pointed shell, and was naturalised in the River Avon, Christchurch, to serve as food for the trout.

The native slugs belong to the genus *Athoracophorus.* These are about an inch in length, and yellow, brown, or black in colour, and, as in most slugs, the shell is only a thin plate quite covered by the skin of the back. These animals frequent dark and moist places, being found especially on the under sides or beneath the bark of fallen logs, or in moist leaves and moss; *A. papillatus* for example is very common under logs in Riccarton Bush and Banks Peninsula. These slugs may be recognised by the tentacles, of which there is only one pair, whereas the introduced slugs have two pairs; and they also have curious lines on the back—a line down the middle and numerous branches somewhat like the veins in a leaf.

The multitudinous land-shells cannot be mentioned here in detail. The commonest is *Endodonta coma,* about a quarter of an inch across, circular in outline, and flat instead of pointed at the apex. It is of a dull grey colour, and has numerous ridges running obliquely across the turns of the spiral. This description however would apply to numerous other species of

*I have to thank Mr. E. W. Bennett, M.Sc., for assistance in preparing this account of the Mollusca.

Endodonta, Thalassohelix, Allodiscus and other genera, and to identify a specimen recourse must be had to the detailed descriptions in Suter's *Manual of the New Zealand Mollusca* with the accompanying atlas of plates. Some of the shells, especially of *Flammulina,* are very beautifully coloured; *F. crebriflammis, F. pilsbryi,* and especially *F. zebra* may be found in Riccarton Bush.

The mollusca inhabiting fresh water belong to comparatively few species, but are in some cases very numerous. This especially applies to the small black water-snail, *Potamopyrgus* which is to be found in abundance in every pond and stream where the water is not too stagnant and muddy. It can live in the tidal reaches of rivers, and even in estuaries. *Planorbis corinna,* found on weeds in ponds and slow limpid streams, is a very small shell, and (as the name implies) flattened like the land-shells. A curious limpet-like shell, *Gundlachia neozelanica,* is known from the River Avon only. *Amphipeplea ampulla* may be distinguished from *Potamopyrgus* by the large oval aperture of the shell; the colour is horny, and though somewhat variable it is never black. Another very curious shell is *Isidora,* which can easily be distinguished from almost all other shells by the fact that the spiral is left-handed, so that the apperture of the shell is on the side opposite to the usual position. *Isidora* and *Amphipeplea* are fond of muddy water where *Potamopyrgus* cannot live.

All the molluscs mentioned so far belong to the *Gastropoda,* in which the shell consists of one piece only; there are however also two others of the bivalve type. *Corneocyclas novæ-zelandiæ* is a small round white shell, common in rivers, streams, and ponds. The fresh water mussel *Diplodon menziesi* which is about two inches long and has a black shell covered with a horny black outer layer (except at the widest part, where it is always worn and corroded), is one of many animals whose distribution shows some relationship between New Zealand and Australia, South Africa, and especially South America; it is related to the *Unio* of the Old World, but not to the marine mussels (which, for example, attach themselves to

rocks by threads). *Diplodon menziesi* can be collected in numbers with a rake from sandy parts of the River Avon and other similar streams; this is a remarkably variable species, no less than seven subspecies having been described.

Space forbids mention of the wealth of large and beautiful shells to be found on the sea-shore; they are not different in any important respects from those of other parts of New Zealand, though some of the Northern ones such as the common *Ethalia zelandica* are absent or very rare. Bivalves may be found in abundance on sandy shores (pipis, trough-shells, Venus-shells, the boring *Saxicava* and *Barnea),* and many others, and most of these have one or two related species which prefer the stiffer mud of estuaries. On the rocks are others, chiefly the mussels, while here and on the sea-floor are abundance of Gastropods—Cats-eyes, whelks, limpets, and hosts of others; while the Chitons, Pterpods, squids, and the Octopus are types of marine molluscs living on the sea-shore or washed upon the beaches.

Arachnida.

Spiders are common but not large or specially noteworthy except the *Lactrodectus katipo,* a small black spider with red mark on the abdomen, the bite of which is poisonous; it occurs on sandy beaches and other places but not usually far from the sea. Trap-door spiders are to be found on the hills of Banks Peninsula and other suitable localities. Phalangids with long slender legs are numerous in the bush and a Chelifer is frequently met with.

Earthworms.

Numerous species of earthworms native to New Zealand were plentiful before the land was ploughed for cultivation and may still be found in places where the natural plant-covering is undisturbed. Some of them are of fairly large size, e.g. *Octochaetus multiporus.* In cultivated fields they have been entirely replaced by species of *Lumbricus* and other European worms. Planariass or flat worms, *Geoplana* spp., are common and some of the species show much diversity in colouring. A land Nemertian has also been described.

MYRIAPODA.*

Centipedes and *Millipedes* which are really as distinct from each other as spiders and crustaceans, are quite common in Canterbury but do not grow to any great size. Most of the orders of millipedes are represented and include species of the genera *Iulus, Polydesmus, Huttoniella* and *Strongylosoma.* Several new species of New Zealand millipedes have been recently described, but from North Island specimens, and comparisons of southern forms with these have not yet been made.

The Centipedes are better known. The most primitive of these belong to the order Geophilomorpha, and are long slender straw-coloured worm-like creatures with many pairs of legs. Although they wriggle actively enough when disturbed, they are slow in actual progression. Not infrequently a large centipede of this type is dug up in our gardens; it is *Zelanophilus wheeleri.* Those of this type which live in the bush are usually smaller, an inch in length, or less. Of the twenty species in New Zealand only six have been recorded from Canterbury, but there are probably more.

The order Scolopendromorpha have only 21 pairs of legs, but this concentration of leg power has given them greater speed. The large (six-inch) centipede of the North Island is replaced in North Canterbury by the two-inch *Cormocephalus violascens* belonging to the same genus; but much commoner are two species of *Cryptops, C. dilagus and C. australis,* small blind form from an inch to an inch and a half long. They differ from other New Zealand representatives of the genus in having certain characteristic pores on the base of the last legs reduced in number and size, this being probably associated with the drier climate of Canterbury.

Still further reduction in the number of legs is found in the Lithobiomorpha, but their fifteen pairs of legs are long and carry them very quickly indeed. On the hillside a small brown form *Henicops maculata,* can be found under large stones in the grass; its

*This account of the Myriapoda has been kindly prepared by Mr. Gilbert E. Archey, Curator of the Auckland Museum.

speed is amazing and it is very hard to catch. In the bush we find the deep reddish-brown *Paralamyctes validus,* small reddish species of *Lamyctes* and yellow forms of *Wailamyctes* and *Anopsobius. Anopsobius neozelanicus* is of interest in that it belongs to a genus whose other species live in South America.

A species of great systematic importance is *Craterostigmus tasmanianus* first described from Tasmania. When seen from above it exhibits 21 segments, but on the under side it has only 15 ventral plates and 15 pairs of legs. It thus definitely connects the 21-segmented Scolopendromorpha with the 15-segmented Lithobiomorpha and indicates the course of specialisation in the evolution of the Centipedes. It also possesses some of the characteristics of the still more primitive Geophilomorpha. It lives under sticks and stones in very damp situations by the side of streams. It has been collected at Cass and Mt. Grey in Canterbury and in Central Otago.

Another group of Centipede-like creatures found in Canterbury are the Symphyla, which is however a distinct class of the Arthropoda with some of the characters of primitive insects. They are very small and white in colour, and live among leaf-mould in the forest floor. There are probably several species to be described, but so far only one, *Scutigerella caldaria,* has been identified. They can be distinguished from the true centipedes by their having two short processes projecting from their hinder end, as well as by their small size and pale colour.

History of Canterbury Entomology.

By A. L. Tonnoir, Cawthron Institute, Nelson.

The 'seventies saw the dawn of Entomology in Canterbury, and the history of this science for the Province remains for a long time the same as the history of New Zealand Entomology, thanks to the activity of such keen students as R. W. Fereday, C. M. Wakefield, E. Meyrick, W. M. Maskell and Captain Hutton, each of whom resided in Canterbury during longer or shorter periods of time.

Fereday and Wakefield seem to have started together, but as the sojourn of Wakefield in Christchurch was rather a short one, and as he disappears first from the scene, it is thought best to speak of his work to begin with.

At that time, Entomology was still considered as a minor branch of natural history, and we hear Wakefield complain that butterfly or beetle hunting was too freely ridiculed by the public at large; this, however, did not prevent him from doing some very useful and successful collecting.

We note the first sign of his entomological activity in 1873, in the shape of a small paper *(Trans. N.Z. Inst. V.)*, published under the title of *Remarks on Coleoptera of Canterbury*, in which a brief review of that Order is given. However, he must have been busy during a number of years previous to this in forming a collection which he intended to submit to specialists in England. Unfortunately this valuable collection was lost on its way in the wreck of the *Blue Jacket*. In order to put on record the most important data pertaining to this lost collection, he published a general account of it from memory. This account did not contain any very accurate or important information, owing to its unreliable documentation. His estimate of the number of New Zealand beetles amounts to 500 species—a very low estimate indeed, as the number of known species to-day reaches some 4,500; his opinion

was formed on the relatively poor fauna of Canterbury and especially of the vicinity of Christchurch, which must have been his main field of investigation.

The years 1873 and 1874 saw him busy in forming a new collection which he then sent for study to H. W. Bates in England. In *Some Notes Upon Recently Described New Genera and Species of Coleoptera from Canterbury* Wakefield complains of the lack of literature on the subject in the Colony, and he advocates the working out of the insect fauna of New Zealand by outside specialists who would have to send back named specimens which would be used as a base for New Zealand students to work upon. This method of procedure has been adopted by a good number of entomologists, with the result that many types have been lost to the country and are now scattered in European or American collections.

Wakefield urged also that all descriptions of New Zealand species, if published elsewhere, should be reprinted in the *Transactions of the New Zealand Institute*. This proposition was agreed to, and in Volume VII. appear two papers by H. W. Bates which had been originally published in *The Annals and Magazine of Natural History*. It is to be regretted that this practice should not have been kept up after this first attempt, as there is now an important amount of descriptions of New Zealand species scattered in many periodicals which are not within easy reach of New Zealand students.

In the first of these papers about 200 species of carabid beetles are described, these having been collected for the greater part by C. M. Wakefield and R. W. Fereday in the vicinity of Christchurch.

The second paper deals with the Longicorn beetles of New Zealand. It was based only partly on material collected by Wakefield and Fereday; however, most of the notable species of this attractive family found in Canterbury are mentioned in it.

Unfortunately, Wakefield had to leave New Zealand towards the end of 1875, never to return; he was then made an honorary fellow of the Canterbury Philosophical Institute, of which he had been the secretary during several years. Had he remained here,

New Zealand Entomology would have progressed at a keener pace, thanks to his untiring activity; as he said himself, his aim was to introduce something like order into the chaos of New Zealand Entomology. Wakefield did not confine his interest to Coleoptera; he also diligently collected all other orders of insects except Lepidoptera, which he entirely left to his colleague, Fereday. Thus he sent for identification and description many Neuroptera *(sensu lato)* to McLachlan and Hemiptera to Scott. Wakefield took his collection with him to England, but after his death it was bought from his widow by the Canterbury Museum. As far as the Coleoptera are concerned, this collection is specially precious because many of his specimens were studied by Dr. Sharp after Wakefield's return to England.

R. W. Fereday was also a very keen collector of insects, but his greatest, and later his only, interest was in the Lepidoptera, which he studied diligently and on which he published a few original papers; his entomological work reached, therefore, a higher standard than that of Wakefield. Fereday was a corresponding member of the Entomological Society of London.

His first paper appears in 1871 *(Trans. N.Z. Inst.* IV. p. 214) and if not the first contribution to New Zealand Entomology, it is at least the first one concerning Entomology in Canterbury. In this paper, Fereday gives a general survey of his collecting work which had been quite important, eight species of butterflies and three hundred of moths having been sent by him to England for identification; seven-eighths of these species were new to science, and were mostly described by Walker, Guénée and Butler.

Fereday was also the first in New Zealand to consider Entomology from an economic point of view, and in a paper *(Trans. N.Z. Inst.* V. p. 189) he gives a full account of such noxious species as the grass grub, the woolly aphis, the pear slug, etc., and mentions also a certain number of indigenous moths which attack introduced economic plants. Fereday advocates here, for the first time in New Zealand, the biological control of these pests, not only by birds, but also by means of other insects, such as dragon flies, lady birds, carabid beetles and ichneumons.

In 1894 Fereday published his first list of New Zealand Lepidoptera, in which he records 540 species (as against 1,300 known to-day) which had been described by English specialists. This list contains very few critical notes, and the author made no attempt at ascertaining the validity of the species—it is merely a compilation of the species recorded from New Zealand previous to 1871. Then from the year 1876 to 1883, Fereday published a series of small papers in which he describes the most important of his captures, devoting his attention specially to the butterflies. His first really important contribution is his study of the variety of the genus *Chrysophanus* (*Trans. N.Z. Inst.* X. p. 152), which is accompanied by a good plate. Also the descriptions of the two rarest and most interesting species of New Zealand butterflies, *Erebia butleri* and *Dodonidia helmsi,* are due to his pen (1880 and 1883). Fereday ceased describing new species of Lepidoptera towards 1884, after the arrival of Meyrick in Canterbury, judging probably that the latter was better qualified for this side of the work; but his interest in Lepidoptera was none the less keen for that, and he still went on collecting most actively, steadily enriching his already important collection.

Fereday had been helped to a great extent in forming this collection by Mr. J. D. Enys, of Castle Hill, another ardent and zealous collector of Lepidoptera, who had also sent for study important material to the English lepidopterist, Arthur G. Butler. In 1880, Enys published privately a catalogue of the Butterflies of New Zealand, in which he gives a complete account of what was known of the Rhopalocera of the country. Fereday contributed to this pamphlet by the description of a new species of *Erebia,* and by the drawing of one of the plates.

The now world-famous lepidopterist, Mr. E. Meyrick, led by his passionate interest in the study of Lepidoptera, came to New Zealand towards 1882, and settled in Canterbury as a teacher at Christ College, Christchurch. His first paper to be read before the Philosophical Institute of Canterbury, in 1883, deals with twenty-eight new species found mostly among Fereday's material. However, Meyrick collected him-

self quite extensively, in company with Fereday, around Christchurch, and with Enys in North Canterbury, chiefly near Castle Hill, Mt. Hutt, the Bealey River, Arthur's Pass and Otira. Thus, in possession of a large amount of material, he published in 1884 two papers which can be considered as the first really extensive and important contributions to Canterbury Entomology. One of these, his monograph of the New Zealand Geometrina, deals with no less than eighty-nine species for which Fereday supplied him with notes of habits and localities. After a trip to England, where Meyrick had the opportunity of examining all the types of New Zealand Micro-lepidoptera in the British Museum, obtaining thus a sound basis for his subsequent work, he prepared a series of four papers, in which he revised, in monograph form, such important groups of the New Zealand fauna as the Scopariidæ, the Pyralidina, the Tortricina, the Tineina, and the Noctuina, in which a considerable number of new species were described. These studies were still based for the greater part on material collected in Canterbury by himself, and to a large extent also by Fereday, especially as regards the last group, to which Fereday had devoted special attention.

Meyrick seems then to have exhausted the possibilities of Canterbury as a collecting field, and his subsequent studies on New Zealand moths during the two following years, until his return to England, are devoted to southern or northern species.

The extent of Meyrick's entomological activity in Canterbury can be adequately realised by the comparison of Fereday's first list of known New Zealand Lepidoptera mentioned above, and the new list publishel by the same author in 1898 with the help of Captain Hutton. This list mentions 625 species and gives full references and synonymic data. With a very few exceptions all the species therein enumerated were included in Fereday's collection which is now in possession of the Canterbury Museum, and forms the most important asset of the entomological collection of that institution. While this important work was being done on the Lepidoptera in Canterbury, another star arose in the field of Canterbury Entomology. The reference is to Mr. W. M. Maskell, who appeared on the

scene in 1879, with a paper on New Zealand scale insects, in which many new species were described. This work was based mostly on specimens collected in Canterbury by himself or by Dr. L. T. Powell, of Christchurch, who by a few brief notes had already shown his interest in entomology. The scale insects afforded Maskell a gratifying field of study, because apart from the work of Signoret, little had been done in the whole world on this economically very important group of insects. This is easily realized from the fact that Maskell was the first to describe as a New Zealand species that almost cosmopolitan scourge, the cottony cushion scale.

This first paper was followed by three further notes from 1880 to 1883 (*Trans. N.Z. Inst.*, Vols. XII., XIV. and XVI.) bringing the total of the New Zealand species to fifty, but these were species described from specimens sent to him from all parts of the country, the attention of other naturalists having been directed to this group by Maskell's first paper. Towards that time Maskell left Canterbury to go to Wellington, where soon after his arrival he published his book, *An Account of New Zealand Scale Insects*, which is the outcome of the work he had done while studying in Canterbury.

At the time this book was considered as a standard work on the subject, although his descriptions of the species and his drawings were rather superficial, as was the case with his earlier papers.

A part of his very valuable collection composed of specimens mounted on slides, and others in spirit, was handed over to the Canterbury Museum, but no record exists as to how and when this collection came into possession of the Museum. It seems to consist only of duplicates, his main collection being left in charge of the Department of Agriculture; it is now being revised by H. Morrison, of Washington.

Before coming to Canterbury in 1880, Captain Hutton had made but few contributions to Entomology, his first attempt being a list of the insects, exclusive of Lepidoptera known from New Zealand previous to 1870, in which he was helped by Wakefield, chiefly as regards the Coleoptera. This list records 502 species, which, with the Lepidoptera listed by Fereday at the

same time, brings the total of these known to New Zealand insects to 848 species, as against 8,158 mentioned in Dr. Tillyard's census, included in his recently published manual of Australian and New Zealand insects.

Soon after his arrival in Christchurch, Captain Hutton set himself to work again on the census of New Zealand insects, and published in 1881 his *Catalogue of New Zealand Diptera, Orthoptera and Hymenoptera,* but this time it was not a mere list of species, as he gives their descriptions, mostly after the authors, and adds a very few descriptions of his own, with some keys to genera.

It was only in 1897 that he started his original work on New Zealand insects with an account of the Stenopelmatidae, or Wetas, in which thirty-three species are dealt with, the new species mentioned therein being mostly obtained from Canterbury, or from Wellington through Mr. G. V. Hudson.

Then follows, in the years 1898 and 1899, a series of papers on the rest of New Zealand Orthoptera *(Acridiidæ* and *Phasmidæ),* a series of good papers which remain so far the only substantial contribution to the knowledge of this very peculiar part of the insect fauna of this country. This being done, Hutton turned his attention towards the Hemiptera and published a memoir on this Order *(Trans. N.Z. Inst.* XXX.) in the form of a synopsis which deals with eighty-two species among which twenty only are recorded from Canterbury. The following year, Hutton sums up, in a rather extensive paper, what is known of the New Zealand Neuroptera *(sensu lato)* and from that time onward he devotes all his entomological activity to the study of Diptera, which had been very much neglected so far. He began the series of his papers on that Order with the Tipulidæ or Crane flies. Hutton appears to have been a keener student of cabinet specimens than a collector, and to a rather large extent, the material on which he worked had been obtained through other entomologists. Mr. Hudson, of Wellington, and Captain Broun, of Auckland, among others, supplied him with interesting material. This procedure explains how inexhaustive is sometimes his survey of certain groups. For instance, his paper on the Tipulidæ mentioned forty-four species, whereas more than 500 are known

to-day. Towards that time, P. Marshall was commencing his scientific career. At the suggestion of Captain Hutton, he undertook the study of New Zealand Diptera, and made his debut with some families of the Nemocera. His first paper deals with the gall midges, and his second and most important one with the fungus gnats which had been scarcely touched before. In this memoir thirty-five species, distributed among twenty genera, are recognised. Nearly all the material under study had been collected in Canterbury; this explains how the number of mentioned species is relatively low, if compared with the 265 species known today for the whole of New Zealand. The collection of P. Marshall, with the exception of his Cecidomyiidae, which did not resist the action of time, is deposited in the Cawthron Institute, Nelson. Captain Hutton then resumed his work upon the Diptera, by the publication of his two main papers on them. His synopsis of Diptera Brachycera of New Zealand, and an addition to this, appeared respectively in 1900 and 1901, and contain the descriptions of about one hundred new species. Through lack of literature and of material for comparison, Hutton often placed the species in the wrong genera, or even in the wrong family; however, his work gave a good foundation to New Zealand Dipterology.

His collection, preserved in the Canterbury Museum, is most valuable; it contains nearly all his types, which are in sufficiently good condition to allow of an easy revision of the groups on which he published.

This collection, the list of Lepidoptera of Fereday and data supplied by Broun for the Coleoptera and by Cameron for the Hymenoptera, were the bases on which he founded the insect section of his famous *Index Faunae Novae Zealandiae,* published in 1904.

After Captain Hutton's death, the bright period of Canterbury's Entomology came to an end. From that time on we note a few sporadic writings of authors. Among these may be mentioned George Marriner, Dr. Chilton, J. W. Campbell, G. Brittin; and in more recent times, S. Lindsay, a keen collector of Lepidoptera, who has just started to publish the result of his labours by a list of the Lepidoptera of Riccarton Bush.

The Native Fishes of Canterbury.

With two plates.

By Gilbert Archey, M.A., Curator, Auckland Museum.

Instead of trying to mention all of the one hundred and forty-two species of fishes known from the Canterbury province I have contrived to combine an outline description of the main types of fishes, based on those which occur locally, with such accounts of their habits as may be of interest. My excuse for the paragraphs on classification is that they will give some orderliness to my remarks, and, I hope, enable those readers who desire to study our fishes more closely, or those who have secured a fish that is new to them, at least to place a specimen in its proper group.

Most of us can distinguish the main orders of insects: flies, bees, beetles, and so on, at a glance, and although the orders of fishes are not so distinctly marked there are certain groups which can be readily recognised.

Modern systematic classification has decided that the differences between the three classes of fish-like creatures are so great as to warrant the restriction of the names "Pisces" to one of them. The three classes are Lampreys and Hag-fishes *(Cyclostomata)*, Sharks and Rays *(Selachii)* and Fishes *(Pisces)*, the latter being the true bony fishes.

It has long been recognised that the Lampreys *(Cyclostomata)* with their skeleton in the form of simple elements, their primitive brain, and their lack of true jaws and of paired fins, were far removed from the sharks and true fishes; but the separation of the last two as distinct classes is a more recent arrangement.

CYCLOSTOMATA: Two species of this class are known in New Zealand, and Canterbury has them both. The Hag-fish *(Eptatretus cirrhatus)* is a marine form, with peculiar teeth capable of considerable protrusion, well adapted for rasping off the flesh of fishes which it attacks. It is cordially disliked by

fishermen on account of the inextricable tangle it makes of a line and the amazing quantities of viscous slime it exudes from a series of pores along the side of the body. The eyes of this almost blind creature are hidden within the skin, but this condition is compensated for by the development of fleshy tentacles (barbels) around the mouth.

There are three stages in the life history of the river-lamprey *(Geotria australis)* which is known from practically all the Canterbury rivers. The eggs are laid in October, in sand at the bottom of a nest of stones in the river, and the small larval form *(Ammocoetes)* which hatches out is eyeless and toothless. Apparently this form goes to sea, or to the estuaries, for the sexually immature stage *(velasia)*, with its long thin body, small head and small sucker closely set with teeth, ascends the rivers in spring.

The adult is stouter in body, the head large, the sucker is distended, and the teeth far apart, while a large pouch has developed below the mouth. The last two stages were considered as separate species until Dr. Dendy described the life history in full. *Geotria* is a southern genus being also found in South America, where other pouched adults occur.

Sharks and Dogfishes, Skates and Rays, and Elephant Fishes, three well-defined groups, together comprise the *SELACHII*.

It is fortunate that, on the whole, the sharks that frequent our coasts, or at least those that come close inshore, are relatively harmless creatures. Nevertheless we have to record some of the voracious man-eating types, including the notorious Great White Shark. Large, fast-swimming, pelagic sharks are however more common in warmer seas, and it is only in an unusually warm summer that these dangerous species are likely to become numerous off our coasts.

Most of the sharks that occur in New Zealand waters have been recorded in Canterbury, and the same indeed applies to many of the bony fishes especially those which range off shore, to whose dispersal no appreciable barrier exists.

The Seven-gilled Shark *(Notorhynchus pectorosus)*, is a rare type that has been taken once in Lyttelton

and only twice elsewhere in New Zealand. Most sharks have the gill-slits reduced to five, but those of the order to which this species belongs have, more primitively, 6 or 7, and in addition can be distinguished by their single dorsal fin. This species is probably a wanderer from Australian seas.

The second order of sharks has two dorsal fins and an anal fin. Most of the large sharks, and those to be feared, belong to this order; but the first to be mentioned, the rather flat-headed, broadly mottled Carpet Shark or Cat Shark *(Cephaloscyllium isabella)* does not seem to grow much more than three feet in length.

The Smooth hound *(Mustelus antarcticus)* is the small spotted dog-fish frequently taken in Lyttelton Harbour and around the coast. It is the commonest shark in New Zealand and is often known as the Gummy on account of its flattened pavement-like teeth. The Tope *(Galeorhinus australis)* is a medium sized shark, usually about 4½ feet long, which often leaves the open sea or shallow harbour waters, but neither it nor the ten foot Whaler *(Carcharinus brachyurus)* seem to be dangerous, though other species of *Carcharinus* are reputed man-eating sharks in tropical seas.

Three sharks built for speed are the Mako, the Porbeagle and the Great White Shark. Each has a powerful tail with upper and lower lobes of the caudal fin about the same size; the forward fins are very large and powerful; and (a distinguishing character) a prominent keel or flange runs along either side of the tail.

The teeth of these three sharks were prized as ornaments by the Maoris, and it is by the teeth that we can distinguish them. The Porbeagle *(Lamna nasus)* has long sharp teeth, each with a small cusp at the base on either side; the Mako *(Isurus glaucus)* has teeth of similar shape without the cusps, and the Great White Shark *(Carcharodon carcharias)* has large triangular teeth with serrated edges. All three are voracious, but the Great White Shark is generally held to be the most dangerous shark now living. A

specimen from Port Levy in the Canterbury Museum is 11 feet long, but 30 feet specimens have been captured in other parts of the world.

The Thresher shark is related to these swift mackerel sharks, its most striking feature being the extension of the upper lobe of the tail fin into a long blade-like process by means of which it rounds up schools of small fish, its normal food.

From these large sharks we must now turn to the very much smaller "dog-fish" and related forms, comprising an order of sharks lacking the anal fin. Only two need mentioning—*Scymnodon sherwoodi,* a small brown shark cast up on the New Brighton beach in 1920, and the Spiny Dog-fish, *(Squalus fernandinus),* eighteen inches to two feet in length and almost as common as the Smooth hound. The spines indicated by its vernacular name are one in front of each dorsal fin; it is viviparous, the brood of young varying from eight to seventeen.

Skates and Rays are in effect Sharks which are flattened from above in conformity with their shallow water habitat, and the order is represented in Canterbury by a Skate, a Stingray and an Electric Ray. The two former frequent the estuaries but go to sea as well for the *Nora Niven* expedition secured them at all depths up to 105 fathoms. The cruelly barbed spines on the tail of the Stingray have no specific poison, but the slime which covers them may increase the danger of blood poisoning. The Torpedo Ray *(Typhlonarke aysoni)* or blind numb-fish is a small brown, soft-bodied fish which lurks on the bottom in moderately shallow water. It can paralyse its prey by an electric shock given by a special organ, composed of two concentrations of modified muscle tissue. Specimens have been caught at Sumner and Lyttelton but the fish does not appear to be common.

ELEPHANT FISHES: The strikingly-patterned elephant fish *(Callorhynchus milii)* with large flopping fins is well known (as "Silver Trumpeter") to all fishermen along the coast. It is a member of the *HOLOCEPHALI,* the third main group in the classification of the Selachii, distinguished externally by the gill-slits being covered by a fold of skin, so that, as in

bony fishes, only one opening is apparent, and, internally, by the very primitive nature of the backbone.

The Elephant fish is oviparous, the egg being provided with a horny case, flattened oval in form with a stiff fringe or frill. Hundreds of these are frequently to be seen cast upon the beach at New Brighton: but they are spent cases, it being very seldom that an embryo is found in one.

The curious projection from the snout, from which it is named, is plentifully supplied with nerves and is probably a sensory organ. *Chimaera novae-zelandiae* is another elephant fish less frequently seen.

THE TRUE FISHES *(TELEOSTEI).*

In introducing the "bony fishes" a further brief word on classification is necessary. If these fishes could be separated into two divisions, as the older classifications somewhat broadly had it, they would be the *soft-finned* "Malacopterygii" and the *spiny-finned* "Acanthopterygii." But the problem is not so easy, and there are even many deviations from an otherwise clear line of progress or gradual change from the soft-rayed to the spiny-rayed type.

Plate I. fig. 1 represents the New Zealand Pilchard, a member of the most primitive order (Isospondyli) of bony fishes. The primitive characters are that the fins have only soft rays to support them and that the hinder (pelvic) pair are situated in the abdominal region of the body; moreover their internal support (the pelvic girdle) is not connected with other parts of the skeleton. The European herring and the salmon and trout are the best known members of the order. Evolutionary specialisation of the higher orders has been in the direction of replacing the anterior soft rays of the fins by sharp unbranched spines and by the gradual moving forward of the pelvic fins, half-way towards the pectoral fins ("subabdominal") in the sea-mullet (fig. 2), right under the pectorals ("thoracic") in the groper (fig. 3), and actually in front of them ("jugular") in the red cod (fig. 4). In the last two, moreover, the pelvic girdle is definitely attached to the pectoral girdle, and the two pairs of fins are therefore intimately associated. These changes in the nature of

the fin rays and in the relative positions of the fins are the bases of the classification of the bony fishes, but the reader will notice that the red cod (fig. 4) rather upsets the general idea, for although its pelvic fins are furthest forward it still has only soft rays. It is one of the deviations from the main line of evolution referred to above, and, to avoid going more deeply into the problem of classification we may merely mention here eels, flat fishes, ribbon fishes, and sea horses, as other, more obvious, examples of divergent types.

Two small members of the primitive "herring-salmon" order, the *ISOSPONDYLI* might be of great commercial importance were their habits and movements more definitely known. The Southern Pilchard *(Sardinia neopilchardus,* Pl. I. fig. 1) and the New Zealand Sprat *(Clupea antipodum)* are known from Canterbury, but there are no local records of the vast shoals which have been reported from other parts of the coast. The pilchard appears to shoal in immense numbers in bays and harbours in the winter and from Queen Charlotte Sound the fishing interests supply smoked "Picton Herring" regularly to the Wellington market. Extensive shoals of sprats have also been observed, principally off the east coast of Otago in the summer, apparently moving southward. At the onset of cold weather they at once disappear, and it is possible that an annual migration from north to south takes place in accordance with the increasing summer temperature of the sea. The Silverside *(Argentina elongata)* is another common marine member of the order, while the smelt or silvery *(Retropinna retropinna)* lives partly or mainly in the rivers, from which it seeks the sea or estuaries in autumn for spawning, the young ascending the rivers in the following spring forming part of the whitebait then secured. They are usually rejected by the dealers, at least when they are large enough to be noticed or when they make their presence known by their characteristic smell alternatively described as cucumber or violets!

WHITEBAIT: Much better known and of wider general interest are the native "trout" and "minnows," members of the Galaxiidae, a family closely related to the Salmonidae. All species, and there are several,

are edible, but little attention is paid to them except when the fry of the minnow ascend the rivers in spring and become the delicately flavoured whitebait.

The species of *Galaxias* may broadly be divided into the small, sea-running whitebait minnows *(Galaxias attenuatus),* the larger native "trout" *(G. fasciatus* and allied species), which probably breed inland, and an aberrant species of medium size *(G. borrowsii)* which approaches the Westland mudfish *(Neochanna apoda)* in form.

The whitebait minnow, which when mature is from four to six (rarely seven) inches long, is found in all streams, and was used in the adult stages as food by the Maoris who used especially to trap them as they migrated downstream in the late summer for breeding. Spawning appears to take place in the estuaries and the fry have been observed returning as early as June. The whitebait runs begin definitely in August and continue through the two following months; but in November the shoals begin to include young smelts and bullies *(Gobiomorphus)* which prey actively upon the whitebait, the bullies being particularly voracious.

Whitebait fishing is still a profitable employment in the season, for although the catches appear small when their weight is compared with those of sea fishing, this is offset by the enhanced price the delicacy commands.

The larger mottled brown native trout occur in most of the streams and lakes of Canterbury. Their breeding habits are little known from actual observation, but from the lack of evidence of a seaward migration it is inferred that they breed in the streams and lakes. Mr. F. E. Clarke who specially studied the native trout many years ago, and who had taken specimens up to 23 inches in length, averred them to be quite good eating if cooked twice as long as other fish, but he did not make it clear whether the extra cooking improved the fish or the waiting sharpened the appetite into keener appreciation.

The next order is that of the eels *(APODES),* famous food fishes of the Maori who named Kai-tuna for its eel abundance. Many guesses had been made about the life history of eels until Dr. Schmidt's discoveries in the Atlantic revealed the remarkable

life-story of the European and American species; and more recently we in New Zealand have become indebted to him for his determination of our two species. They are the long-finned *(Anguilla aucklandii)* and the short-finned *(A. australis)* the first of which frequents quick-running rivers, while the latter is found more often in lakes or sluggish streams.

They go to sea to breed and although the transparent, knife-like "Leptocephalus" larvae that have been taken off the coast have not yet been proved to be those of our fresh-water eels, (they may be those of the marine conger eel), the transparent elvers have, on several occasions, been taken ascending the estuaries in spring. The life history is at least on the lines of that of the European eel; but the variety of river mouths in New Zealand, periodically blocked by sand banks or opening into lagoons, present problems in connection with the entry of the elvers and of the egress of the adults, and these, and questions as to how long the eels live in the streams before becoming mature, have yet to be settled.

Galaxiads and eels are the best known freshwater fishes, and we have already mentioned the smelts; but there are two others which, although they are spiny-rayed fishes, might be included here together, so as to make the account of the freshwater fishes complete. Of the two the gobies, more often called " bullies," are by far the better known.

Gobiomorphus gobioides is small, but active and voracious, and can be seen in all slender streams and watercourses darting across the bottom, for "bullies" keep low down. It feeds on weeds and insect larvae, and its average size is four inches, but it has been known to grow to $8\frac{3}{4}$ inches. Breeding takes place in the summer in estuaries, the eggs being laid under the bank against weeds, and the young migrate upstream at the end of the whitebait season.

The Torrent fish, *Cheimarrichthys fosteri* is a small fish allied to our well-known rock cod. Its name is well bestowed, for it lives in the torrents and the swift channels of our rivers, and, in keeping with this habitat, has a large powerful tail, a flat undersurface and enlarged ventral fins, the latter possibly to enable

it to ahhere to stones. On account of its general shape combined with the inferior position of its mouth, it is also known in North Canterbury as the "shark-bully."

Owing to its exceptional habitat it is not often secured, and this was so in Maori times when special procedure in catching and eating it was fixed by native custom.

The remaining fishes are marine, most of them belonging to the more highly organised spiny-rayed fish, but such divergent types as sea-horses and ribbon fishes must first have a word.

The well-known garfish or piper *(Hyporhamphus intermedius)* has the lower jaw protruding far beyond the upper, and uses it for grubbing among the seagrass in shallow bays. It is related to the flying fish family, of which one small dashing surface form, the Skipper, scarce able, however, to rise from the water has been reported from Lyttelton. Snipe fishes (or bellows fish), Pipe-fishes and sea horses, which have the front of the head produced into a snout with small jaws at the tip, are a group regarded as an offshoot from the Garfish, and with them form the order *SOLENICHTHYS.* Three species of pipe fishes and one sea horse are known living among the kelp and seaweeds of harbours and headlands. They have the habit, usually in the males, of carrying the eggs, until they are hatched, in a pouch of skin under the base of the tail.

Still more remarkable are the Ribbon, or Oar-fishes, and the Deal-fishes, of which rare specimens have been cast up on the Canterbury beaches. The Oar-fish, 12 to 20 feet long, with a high, flame-tipped head-crest (the elongated fin rays) is probably the sea-serpent of repute. Its pelvic fins are narrow, elongated processes, hence the name Oar-fish. The Deal-fish is much smaller, but of the same type, but we know very little of the habits of either of them.

MUGILOIDEA. An intermediate stage in the forward movement of the pelvic fins is represented in the little sea-mullet *(Agonostomus forsteri* (Plate I. fig. 2), popularly known as "herring." It is a shore and estuarine form and feeds on the small shrimps which come in with the tide.

The Mackerels and Perch-like fish together form the largest order *(PERCOMORPHI)* of the spiny-rayed fishes, a group in which the pelvic fins have moved forward into the thoracic position and the pelvic and pectoral girdles have been united.

The mackerels (suborder *SCOMBROIDEA)* are swift pelagic fish, many, such as sword- and spear-fishes, being of large size. The only true mackerels recorded from Canterbury are the Pacific Bonito *(Sarda chiliensis)* and the large-scaled Tunny *(Gasterochisma melampus)* which may reach a length of 6 feet; but a related family includes the well-known Barracouta *(Thyrsites atun),* the King Barracouta, *Jordanidia solandrii* (often known locally as Kingfish, but not to be confused with the North Island Kingfish which is a form of Yellowtail) and the elongated, silvery-hued frost fish *(Lepidopus caudatus)* whose curious stranding habits can hardly yet be said to be satisfactorily explained.

The Groper *(Polyprion oxygeneios)* (Plate I. fig. 3) is a typical example of the sub-order *PERCOIDEA* or perch-like fishes, which includes many of our best-known food dishes. The groper may weigh up to 130 pounds, but it is surpassed by the sea-bass *(P. americanus),* which, though not so common, is not infrequently taken from deep banks. A very beautiful member of the same family is the rare Red-fish *(Plagiogeneion rubiginosus)* known only a from a few specimens stranded on beaches. The other members of the order are so well known that we need only refer to their relative abundance.

The Terakihi *(Dactylopagrus macropterus)* is said to be the commonest New Zealand food fish, and it appears to be good buying because a recent investigation into the food value of our market fishes placed it first—yet it is usually the cheapest. The Trumpeter is rare, but its close relative the Moki *(Latridopsis ciliaris)* is secured in good numbers near the kelp, as also are Butterfish *(Coridodax pullus),* and Trevally *(Longirostrum platessa).* One of our best food fishes is the *Warehou,* which, although rare from Lyttelton to Timaru, seems to be abundant at certain periods off Kaikoura.

The Snapper is a very rare fish in Canterbury, but a 19lb. specimen was recently caught from the New Brighton pier.

ROCK POOL FISHES. A common member of the family of Gobies, the "bully," has already been mentioned in connection with the fresh water fish, but the family is really one of rock pool fishes, and three other species, all small forms, frequent the coasts. More numerous still in both species and individual members are the Blennies, small spiny-rayed fishes in which the pelvic fins are placed far forward under the throat. Of the fifteen species in New Zealand five are recorded from Canterbury, but rock-pool fishes are relatively little known, and it is possible that more species remain to be discovered. Another common rock-pool fish is the red sucker fish *(Diplocrepis puniceus)*, which has "jugular" ventral fins, between which folds of the skin and certain muscles are modified to form a powerful adhesive disc.

Several "jugular" fish are mentioned together here for convenience, but they are not regarded by systematists as a single group for they differ considerably in other characters. For instance the Rock-cod *(Parapercis colias)* a comparatively rare line fish in Canterbury waters, has spiny-rayed fins, while the red cod has all soft fins. The latter is caught plentifully by line and trawl, but is not highly regarded as a food fish, while its close relative the Hake or Whiting *(Merluccius gayi)*, is much less common but is not more eagerly sought after on that account. The Rat-tails, which have the tail tapering off to a point, belong to the same order, and two of them *(Coelorhynchus australis* and *C. aspercephalus)* have the mouth placed below the sharp snout in a very shark-like manner. The ling, a large food fish belongs to the family of cusk-eels, noted for their eel-like tail and fins, and the extreme forward position of the ventral fins, which, in the form of a pair of barbels, lie *under the chin.* It is an extremely common trawl fish, especially in the South Island and may weigh up to 20lbs. The Stargazers or "Catfishes" are related to the Rock Cod and the Torrent fish of the rivers; and are of interest

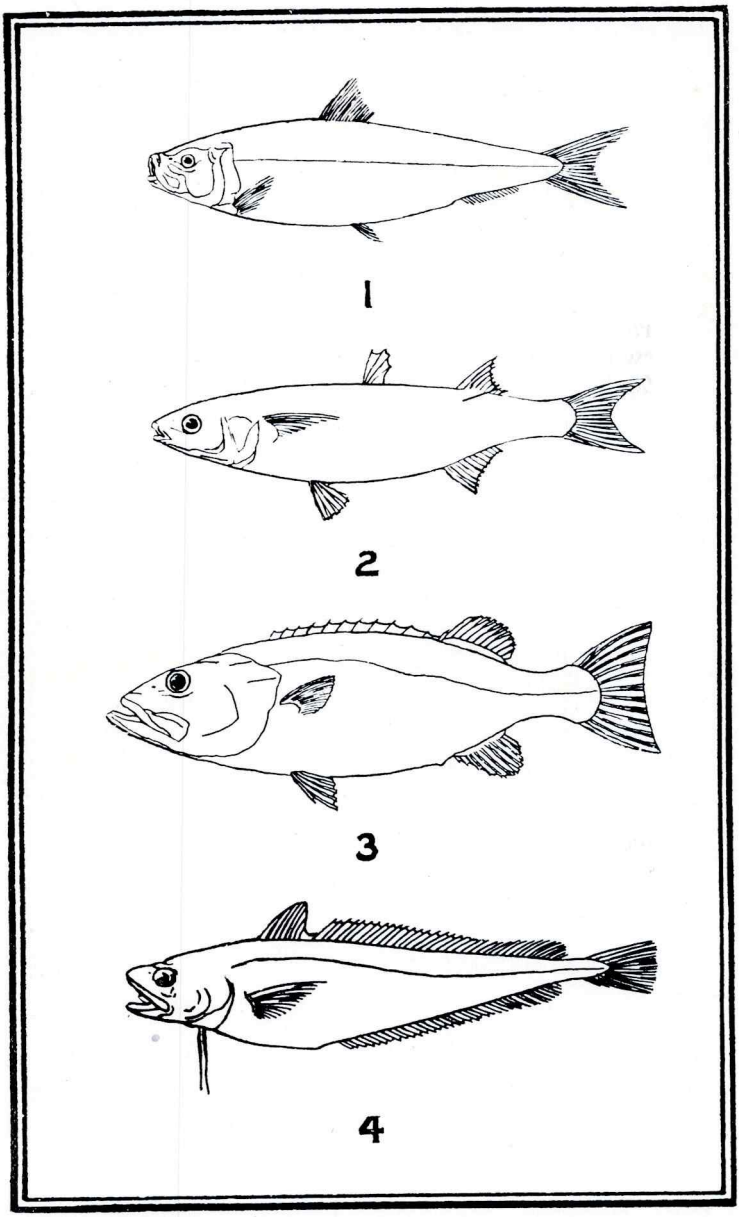


Plate I.: Drawings of sea fishes (after Hutton).

in that one of them *(Geniagnus monopterygius)* frequently ascends rivers and has been found in the Avon and 40 miles up stream in the Rangitata.

The common Red Gurnard *(Chelidonichthys kumu)* and the larger, but less common Spotted Gurnard *(Pterygotrigla picta)* are "mail-cheek" fishes (order *SCLEROPAREI)*, which are perch-like in all but that the head and the gill-covers are strongly armoured and freely studded with strong spines. The Soldier-fish *(Scorpaena cruenta)* and the variegated horror with the droll name of Hapuka's Grandfather *(Helicolenus percoides)* are members of the same order, as also are the Pig-fish *(Congiopodus leucopœcilus)* and the Toad-fish *(Neophrynichthys latus)* whose names appropriately suggest something out of the run of ordinary fish shapes.

ORDER HETEROSOMATA OR FLAT FISHES. Plate II. All the well known market flat fishes of New Zealand occur off the Canterbury Coast and good hauls are taken in Lake Ellesmere and the harbours, while the trawlers secure them in considerable numbers in quite deep waters off the coast.

The following paragraph is intended to be a key, a clumsy one perhaps, by the careful reading of which a specimen of any one of the local flat fishes may be identified: the critical characters are in italics.

The "commonest and most widely distributed of the flat fishes of New Zealand, and yet, unfortunately, the least valuable," is the Megrim or Witch (Plate II. fig. 1). It is our only *left sided* flat fish, and is a very thin species full of long bones. The genus *Rhombosolea,* which includes our commonest market flounders, has developed *right-sidedness* to such an extent as to have completely *lost the left pelvic fin* of which a *vestige remains in the other genera.* The four species of *Rhombosolea* are distinguished by form and colour. The best known is the Sand flounder, or simply Flounder, *(R. plebeia)* (Plate II. fig. 2) *wider across* than the other, while the Greenback *(R. tapirina)* with white undersurface, the Yellowbelly *(R. leporina)* and the Black flounder *(R. retiaria)* have their *distinguishing colours* recorded in their common names. The last mentioned, which is spotted above

with red, is a river flounder, chiefly caught in Canterbury at the mouth of the Selwyn River in Lake Ellesmere "where it is considered to be a winter fish, being very rarely obtained during the warmer months of the year, but the fishermen profess no idea as to where it migrates." (Waite p. 208).

Of the remaining species with *two pelvic fins,* the Lemon Sole *(Pelotretis flavilatus)* has a *normal snout* like the Flounder, and a broadly mottled upper surface, with lemon underside. The others have a *rounded anterior* end caused by an overgrowth of the snout which in the sole (Plate II. fig. 4), often but quite wrongly called the "English" Sole, *entirely conceals the mouth* from above, while in the last two to be mentioned the mouth is *still visible from above.* These two are the Turbot *(Colistium nudipinnis)* with *broadly blotched upper surface,* and the Brill *(C. guntheri)* (Pl. II. fig. 3) which is marked with *spots* forming lines along the body. Both are large and excellent food fishes, but are unfortunately not at all common.

Our final group is the *PLECTOGNATHI,* a small assemblage of fishes of unusual form generally brought about by exceptional growth of the head. In the Leather Jackets or Trigger fish *(Cantherines convexirostris)* the anterior dorsal fin is reduced to a couple of spines, the first of which is very large and is the characteristic "trigger."

The Globe fishes *(Spheroides)* are small with large heads and the body studded with tubercles. When disturbed and especially when handled by the expert small boy they will obligingly puff themselves out most interestingly and float on the surface for quite a while on being returned to the water. The trunk-fish *(Ostracion fornasini)* has the tubercles united into a bony box of six-sided plates for protection against enemies, while the porcupine fish *Dicotylichthys* has the tubercles specialised into long spines.

Finally we have the sunfish *(Mola mola)* with a large head and deep body very much abbreviated behind so that it appears to be mostly head. It is covered with a tough leathery skin and floats lazily at the surface showing its high dorsal fin.

Many members of the order are highly poisonous,

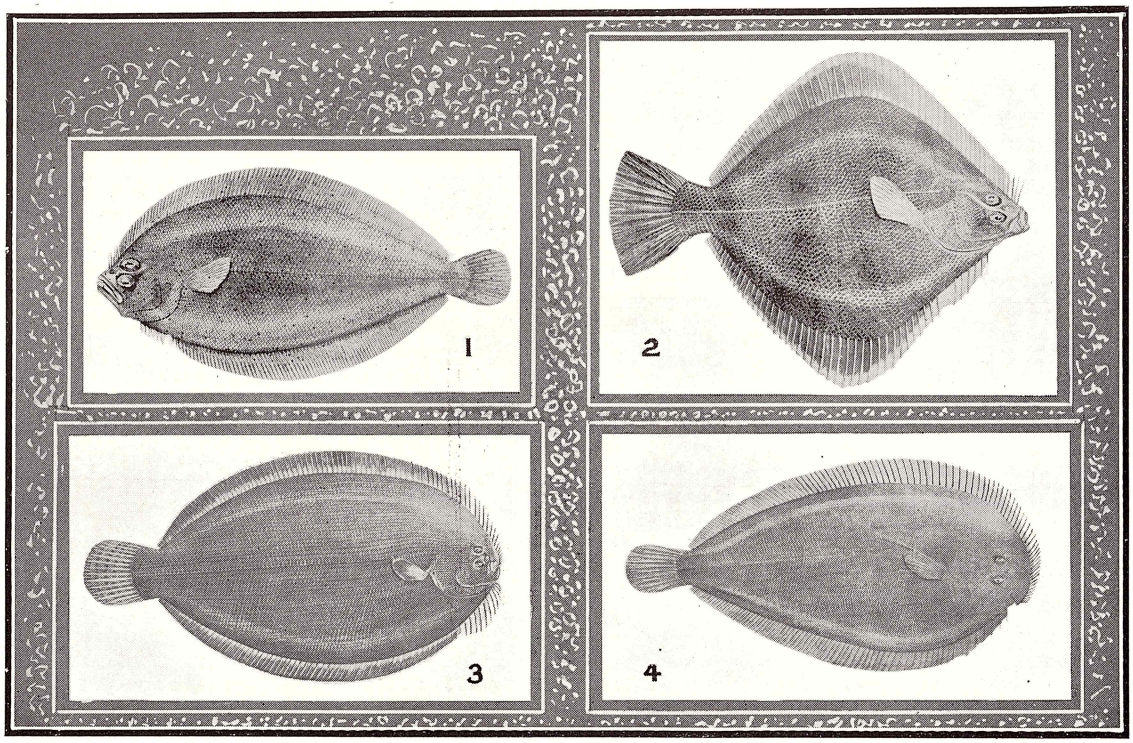


Plate II.: Drawings of Sea fishes (after Hutton).

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producing violent paralysis, but the trunk fishes are an exception in this respect and are, in all parts of the world, often baked in the "shell" or trunk, and I understand that the leather jacket, under another name, is very fair eating.

Canterbury possesses most of the market fishes known in the Dominion, but one should note the very moderate numbers of cold-loving species such as the rock cod and the great rarity of the snapper, dory, mackerel and warm water fish in general. The commonest fish, red cod, terakihi and ling are quite good food fishes and the more delicately flavoured flat fishes are satisfactorily abundant. Altogether about 120 vessels are engaged in the fishing industry, and in 1925 they secured 13,266 cwt. of fish estimated to be worth £23,298.

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2. *The Fishes of New Zealand,* by Captain Hutton. Colonial Museum, 1872.
3. Fishes of the *Nora Niven* Expedition, by Edgar R. Waite. Records of the Canterbury Museum, Vol. I. No. 2 (1909), and 3 (1911).
4. Papers by Günther, Hutton, von Haast, Hector, Clarke, Powell, Dendy, Forbes, Waite, G. M. Thomson and W. J. Phillipps, chiefly in *Annals and Magazine of Natural History* and *Transactions of the New Zealand Institute.*
   Numbers 2 and 3 are extensive papers with many illustrations.

I have drawn considerably from all the above papers and in addition I desire to express my thanks to Mr. W. J. Phillipps and Mr. W. O'Connell for recent information as to the market fishes.

Plate I. Fig. 1. Sardinia neopilchardus. "Fishes of N.Z." fig. 100
2. Agonostomus forsteri. „ „ „ 58
3. Polyprion oxygeneios. „ „ „ 1
4. Physiculus bacchus. „ „ „ 75

Plate II. Fig. 1. Caulopsetta scapha. Rec. C.M. I. Pl. 34
2. Rhombosolea plebeia. „ „ „ 35
3. Colistium guntheri. „ „ „ 40
4. Peltorhamphus novae-zeelandiae. Rec. C.M. I. Pl. 42.

The Native and Introduced Birds of Canterbury.

By Edgar F. Stead.

When Canterbury was first settled in 1851, the Pioneers found a country inhabited by great numbers of birds. The open tussock covered plains and foothills were peopled with plover, rails and quail; various lakes, particularly the great area of shallow water and swamps of Lake Ellesmere, formed an ideal habitat for aquatic birds; and the wide shingle riverbeds afforded a nesting-place for gulls, terns and plovers.

The large areas of bush at Mt. Peel and at intervals throughout the whole length of the western ranges, particularly from the Waimakariri to the Waipara; the bush on the lower slopes of the Kaikoura Ranges, and the whole of Banks Peninsula, contained large numbers of all the South Island bush birds, with the exception of the Kakapo and the Kiwis. In all these forests, the birds have been greatly reduced in numbers, while Banks Peninsula, once containing a greater bird population than most places in New Zealand has, to-day, but a small remnant remaining. The clearing of the bush took away the food and shelter of the birds, and they had to go also. The thrush, saddleback, crow, canary, bush-wren, the parrakeets and the kaka are no longer there; a few robins still survive, while tuis, bell birds, riflemen, creepers, tomtits and fantails fully populate the small remaining patches of bush. The thrush and saddleback are, I fear, extinct in Canterbury, though the canary, bush-wren, parrakeets, kaka, and, possibly the crow, have a last stronghold in the bush-covered mountains of the west. As early as 1875 Potts stated that some of the native birds were getting scarce on the Peninsula, remarking that the saddleback might survive in the Little River Basin. I think that introduced bird diseases were responsible for the sudden and complete disappearance of some species, but the reduc-

of the first birds to become scarce. For this, no doubt, shooting was in some small measure responsible, but tussock fires were far more deadly, for the bird was but a poor flier. I think it very probable that its final extinction, which occured about 1860, was due to some pest or disease introduced with the settlers' poultry. It is curious that the native quail should have become extinct while the very closely allied Australian quail *(Synoecus australis)*, which has been introduced, should survive in suitable localities.

Twenty years ago as one drove in the country, Pipits *(Anthus novae-zelandiae)* would fly on to the road ahead, and run along in front of the horse. They ran with remarkable rapidity and, when overtaken, would rise and fly thirty or forty yards, and then alight and run again. In this way individual birds would travel for perhaps a quarter of a mile, and then fiy away back. To-day, pipits are by no means common, but they are very generally distributed throughout the province and do not seem to have decreased in the past ten years.

The Kea *(Nestor notabilis)* has, by the price put on its head, been greatly reduced in numbers on those parts of the ranges that are stocked with sheep. At the present time, many run-holders are paying as much as 10/- per head for keas. In spite of this, the bird still exists, and, in the inaccessible back country, in considerable numbers. Here we have another of the curious anomalies which are of so frequent occurrence among the New Zealand birds. The kaka, despite protection, is decreasing fast, while the kea, if unmolested, would, it seems, be more numerous than ever, for in the past fifty years it has considerably extended its range northwards. It is a thousand pities that the kea developed a penchant for mutton, for otherwise, a more amusingly playful and confiding bird does not exist. In the museum at Honolulu is a stuffed kea which bears the legend: "Murdered by request of the Honourable Chamber of Commerce."

The Kaka *(Nestor meridionalis)* is now only found in Canterbury away back near the divide. Until about 1912, it still inhabited the bush on Mt. Herbert, Banks Peninsula, and I cannot help thinking that the increasing numbers of opossums there caused the kaka

to depart. Certainly they would inhabit practically every hole in the trees that might otherwise have been used by a kaka as a nesting-site, and I cannot think that a kaka would ever turn an opossum out of a hole.

In the same way the starlings would occupy the nesting holes of the Parrakeets (*Cyanoramphus novae-zelandiae*), which only survived the kakas on Banks Peninsula by a year or so. After the departure of the great flocks of parrakeets which used to periodically visit Canterbury in the last twenty years of last century, the birds became very scarce, and are now confined to the main ranges, and even there are not common. I can remember two of these "parrakeet" years, during the latter of which, in the early "nineties," I spent all my leisure time in trying to snare the birds in the orchard, or hunting them with a catapult. Truly, times have changed! How many of the people who then shot the parrakeets because they ate fruit, would to-day willingly plant fruit trees, if by doing so they could bring back these beautiful little birds to their gardens.

The Fern-bird (*Sphenæacus punctatus*) is, so far as I know, extinct in Canterbury. In 1898 they were fairly plentiful, and could be seen in the swamps near New Brighton, and also in the Culverden district, but they seem to have entirely gone now.

The Rock-wren (*Xenicus gilviventris*) still inhabits the shingle and rock-slips above the bush line on the main ranges. It is usually found in pairs, and, although stoats and weasels undoubtedly go as high as its domain, they do not appear to have greatly affected its numbers. It never was very plentiful. In the winter time it seems certain that these wrens must spend most of their time in the crevices of the rock slips under the snow.

The Native Pigeon (*Hemiphaga novae-zealandiae*), at one time abundant throughout Canterbury wherever there was scrub or bush to shelter it, is still to be found where there is suitable bush, and it receives protection from the man with a gun. Although the destruction of the bush, and the consequent reduction of its food supply, must naturally reduce the numbers of the pigeons in Canterbury, yet the bird would be much more plentiful than it is, if it could only be adequately

protected from callous pothunters. Of a tame and confiding nature, it allows one to approach within a few yards, as it sits sunning itself on a branch, the glorious iridescent green of its neck contrasting with the soft ivory-white of its breast. Occasionally, pigeons come to Christchurch and stay for a while. Last year one such bird inhabited the Domain Gardens and their vicinity for about six months.

At Windwhistle Station a pair or more of pigeons have lived for over forty years, nesting either in the plantations surrounding the house or in some small patches of beech bush nearby. Last year a pair nested on top of an old sparrow's nest in a *Pinus insignis* within a chain of Mr. Leslie Rutherford's house at McDonald Downs. From which it would seem that, if the pigeons are properly protected, they will come to live in the parks and gardens of the towns.

The Long-tailed Cuckoo *(Urodynamis taitensis)* is becoming very scarce in Canterbury. I have seen but four in the last ten years and have only heard but two others. The Shining Cuckoo *(Chalcococcyx lucidus)*, on the other hand, seems to be holding its own of recent years and breeds in the Christchurch Domain probably every year. This cuckoo is particularly fond of the leech-blight which affects pears, cherries, plums, etc.; the only other bird I have seen eating this blight is the chaffinch.

The Tui *(Prosthemadera novae-seelandiae)*, and the Bell-bird *(Anthornis melanura)* are plentiful in suitable patches of bush, but the former seems to be more inclined to local migrations than the latter. The bell-bird is one of the bush birds definitely on the increase in most parts of the province, and in some places, notably near Timaru, has, in the past few years, returned to gardens from which it had been absent for the previous twenty.

The Fantails, both Black *(Rhipidura fuliginosa)*, and Pied *(R. flabellifera)*, are common throughout Canterbury. They frequent suburban gardens, and freely enter houses in search of flies. It would thus seem that they have completely adapted themselves to their changed environment, but there is evidence to the contrary. The heavy snow-storm of 1922 killed practically every fantail in Canterbury except those

in the native bush, where they were apparently safe, and whence, in a few years they quickly re-populated the whole province.

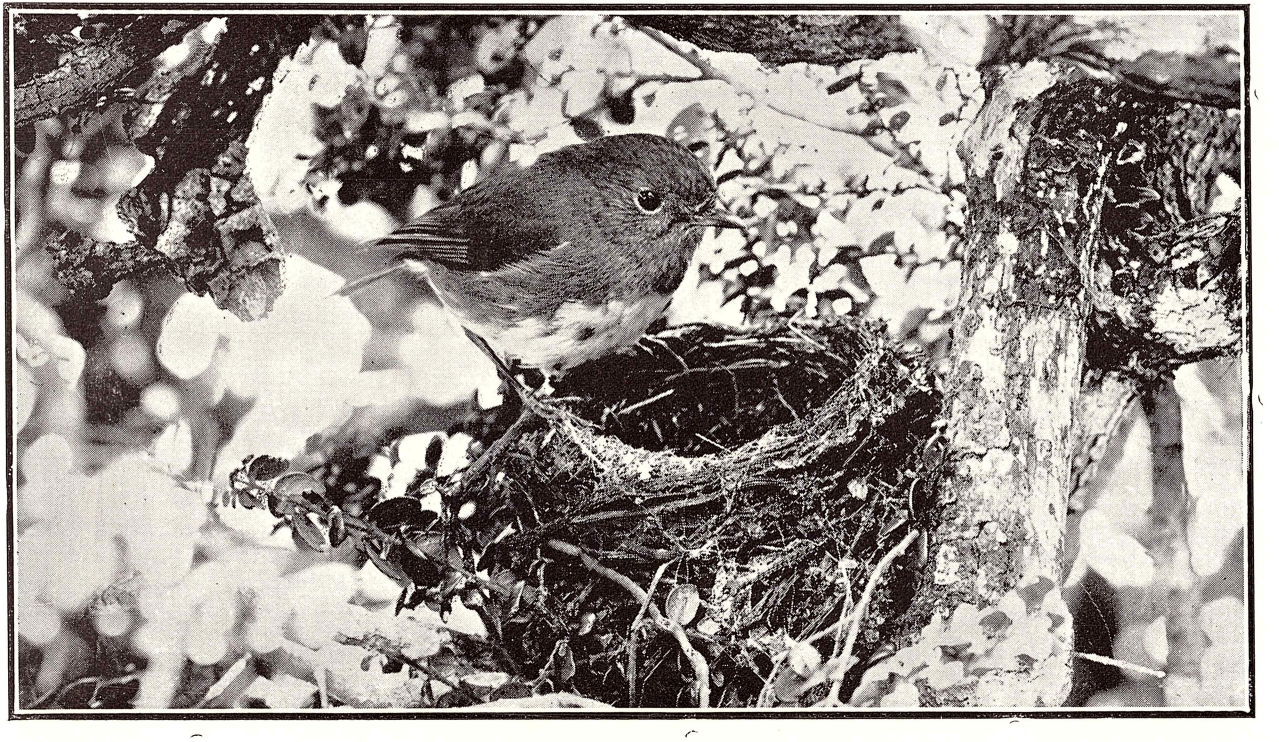
Fantails will rear three or four broods a year, but the black rats destroy a great number of nests, usually when the young are just getting their feathers. The black and pied birds breed freely together, some of the young being black and others pied. I can only remember finding one nest containing young, both of whose parents were black, and in this case the four young ones were black also.

The Rifleman *(Acanthidositta chloris)* is common in all suitable patches of bush and near Waimate has in recent years nested, in increasing numbers, in gardens. I know of several instances where a pair of riflemen have nested in holes in houses; in one case they annually return to the same hole.

Tomtits *(Petroeca macrocephala)* are, I think, slightly on the increase at present. From about 1900 to 1915, it was quite rare to see one in the gardens around Christchurch, but since then they have been appearing more frequently. So long as the ground is damp and the weather wet, tomtits seem to have no difficulty in obtaining food in cultivated gardens; but as soon as the ground becomes dry, the birds, unless they are nesting, will leave. I have several times tamed tomtits that have come to my garden, so that they would feed out of my hand. By making a suitable place for their nest under my verandah, I induced a pair to build there, and as both of the birds would sit on my hand, I had ample opportunities of observing them. The number of grubs and caterpillars that they and their four young consumed *per diem* was prodigious. The young left the nest at noon one Thursday, and the next morning the hen bird was busily building another nest, while the cock fed the young. As soon as the dry weather came in January, old and young birds all left, the old birds returning in April after heavy rain.

By their tameness I was able to recognise my birds after an absence, and it was noticeable that, in one cock-bird which returned for three years, the orange colour of the breast yearly increased in richness.

The Kingfisher *(Halcyon vagans)* is comparatively common in suitable parts of Canterbury, and, if it were



South Island Robin on Nest. [Photo. E. F. Stead.

not for the ignorance of youths with firearms, the bird would be really plentiful. Whenever the ground is sufficiently moist to allow the worms to work on the surface, Kingfishers will be found at very considerable distances from water, feeding chiefly on worms. These birds have quite amazingly keen vision, and I have frequently seen one fly from its perch a distance of fifty yards or more, pick up a worm, and return. Fish form only a small proportion of their diet. In the autumn kingfishers come to my garden and stay, as a rule, until late in the following spring. I have several times seen one catch a mouse and, chuckling with joy, fly off to a stout perch. There it batters the mouse to a pulp, and swallows it whole, thereafter sitting for a long while in quiet content, with its bill slightly open, and the tail of the mouse hanging out on one side.

On the banks of the Avon in my garden is an old weeping willow which has a large hole in it. This hole I fill with puddled clay and, when the clay has set, make a slight hole in it with an auger. This serves as a start for the kingfishers, which build their nest there.

All of the shags which were found in Canterbury and on its coasts by the early settlers, are still here, though in greatly reduced numbers. The big Black Shag *(Phalacrocorax carbo)* was at one time rendered rare by a royalty paid on it by the local Acclimatisation Society. This payment was stopped in 1907, and in the past twenty years the shags have greatly increased in numbers here, especially on and around Lake Ellesmere. It is interesting to note that the trout fishing in the same locality has steadily improved over the same period.

The White-throated Shag *(Phalacrocorax brevirostris)* is still fairly plentiful, though very local in its distribution. It is common on Lake Forsyth, though on Lake Ellesmere, only two miles away, I have only seen one of these shags in thirty years. It is on the lower Waimakariri and the Ashley, yet I know of only one instance of its occurrence on the Rakaia. It is to be found in small numbers on most of the back country lakes.

The Spotted Shag *(Phalacrocorax punctatus)* is still common around Banks Peninsula, where it breeds on the cliffs overhanging the sea. It is much harried

by launch parties of so-called sportsmen who take up a position under the nesting site, and mercilessly shoot the parent birds, leaving the young to die of starvation in the nests.

The Pied Shag *(Phalacrocorax varius)* still survives along the northern coast of Canterbury. I never knew it to occur in this province south of the Waimakariri, though north of that is was at one time quite common. Persistent shooting has, however, thinned it out.

The Frilled Shag *(Phalacrocorax melanoleucus)* occurs here occasionally, as is proved by a young specimen I secured in North Canterbury, at the mouth of the Conway River.

The Gannet *(Sula serrator)* is an occasional visitor to our coast, coming from the north in the summer; a single bird, or perhaps two or three, will stay here for a while, and then go north again. I was once told that a pair bred on Banks Peninsula years ago, but I could not verify it.

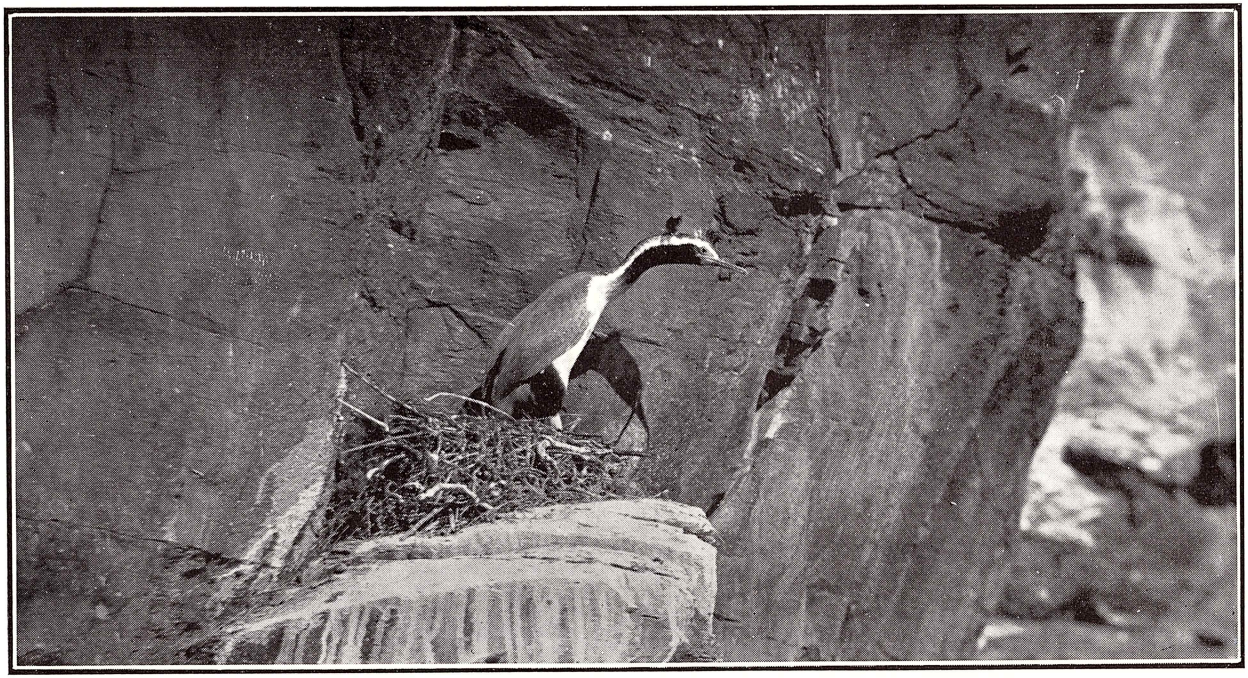
The White Heron *(Herodias timoriensis)*, which was never plentiful in Canterbury, now occurs only as an occasional visitor, usually to Lake Ellesmere; but the Blue Heron *(Demiegretta sacra)* is still a breeding resident of some of the rocky parts of the coast.

The Little Blue Penguin *(Eudyptula minor)* has always been scarce on the coasts of Canterbury, but the White-flippered Penguin *(E. albosignata)* is still a common nesting species in suitable localities. The Victoria *(Catarrhactes chrysocome)*, and the Crested Penguins *(C. pachyrhynchus)* are often found dead on the Ninety-mile Beach, and have occasionally been known to repair to that beach to moult.

The Bittern *(Botaurus poeciloptilus)* is sparingly distributed throughout the Province, and, being now protected, seems to be slightly on the increase.

The Little Bittern *(Ardetta pusilla)* was never common here, and has been extinct in the district for the past twenty-five years at least.

The petrels are probably still as numerous off the coast as formerly, though they have doubtless been driven from some of their ancient nesting-sites by civilisation and introduced vermin. I have found mutton birds *(Puffinus griseus)* killed at their nesting



Spotted Shag, and Nest. [Photo, E. F. Stead.

burrows by stoats or weasels, the small wound on the side of the neck leaving no doubt as to the identity of their enemy. The "Laughing Jackass" *(Oestrelata gularis),* whose weird cry used to be so commonly heard on misty nights throughout the hill country, especially in the river gorges, is now but rarely reported. I have not personally seen or heard one for over ten years. At the Rakaia Mouth, fifteen years ago, I have watched these petrels flying about out at sea. As dusk came on, the birds worked nearer to the shore, until finally at about 7 p.m. they came over the shingle ridge and flew straight up the river. Over the land they flap their wings much more continuously than they do over the sea, and fly with extraordinary rapidity. I never found their nest, though between 1907 and 1912 I spent a lot of time looking for one. That they used to breed in steep bush-covered slopes in the foothills I think is quite certain, but they also went far back into the main ranges. At the mouth of the Acheron River, beyond the Rakaia Gorge, I was fishing one evening when a Laughing Jackass flew past, still going further up the river. In the twilight I happened to see the bird approaching, flying straight into a hard nor'-west wind; it flashed over my head, and in a few seconds had disappeared, travelling at a most amazing speed. Some few evenings later, I was told one had been seen up the Wilberforce River, ten miles beyond the Harper; the bird was still flying westward, although it was already seventy miles from the sea.

As I have said, civilisation has also driven some petrels from their ancestral nesting sites; but I have one very interesting example to the contrary. In 1895 I used to visit a colony of mutton birds, and in 1920 I went back to see how they were getting on. Their nesting site, had, in the meantime, become a popular picnic ground, and I found a litter of paper and banana skins on the bank where the birds had nested; but in spite of this, the mutton-birds were still nesting there.

During heavy southerly gales, it is not uncommon for petrels of various sorts to be blown inland, where they are often picked up in an exhausted or dying condition. The various *Prions* are the species most commonly found. I have one record of a Diving Petrel *(Pelecanoides urinatrix)* and have several times seen,

but not been able to identify, petrels larger than the *Prions* flying before a southerly gale inland from the sea.

The two Grebes found in New Zealand were at one time common on the lakes of Canterbury. The smaller of these, the Dabchick *(Podiceps rufipectus)* has, so far as I know, entirely disappeared from our district, though it is still to be found in other provinces. The Great Crested Grebe *(Podiceps cristatus)*, though gone from Lake Ellesmere, may still be seen in pairs on most of the suitable lakes in the back country, where it breeds in November or December. It builds a floating nest of grasses and rushes, where it can find a suitable anchorage among reeds or branches; but if forced to build on land, does so under overhanging cover near to the water. It seems to be a most unsuccessful parent. I have never yet seen a pair of these grebe with three well-grown young, which would be a full family. Usually, one or more of its eggs will be found rolled out of the nest, or the whole nest destroyed by waves. I found a nest once, anchored to a willow branch in the middle of a small stream. After the bird had been sitting for over five weeks, I took the three eggs, all of which proved to be addled. The nest was very waterlogged, and the undersides of the eggs were always wet, as is the case in all of these floating nests.

The crested grebe seems to be holding its own during the past twenty-five years, and, provided that vandal gunners leave it alone, there is no apparent reason why it should not continue to do so.

The Plover may be divided into two groups: (1) those that breed here, and (2) those that breed in the Northern Hemisphere. Even those that breed here are migratory to a certain extent, breeding in one locality, and then collecting in flocks and moving off to another for the winter.

The large open shingle riverbeds of Canterbury used to be the favourite breeding grounds of the two dotterels, stilts and oystercatchers, but of recent years the great increase in the growth of such exotics as lupin and gorse on the highest shingle-spits has reduced their nesting areas considerably.

Of the two Dotterels, the Red-breasted *(Ochtho-*

dromus obscurus) has become very scarce in Canterbury, whilst the Banded Dotterel *(Ochthodromus bicinctus)* is plentiful in all suitable localities. Why the one species should have almost vanished, while the other, so closely allied to it, and of almost identical habits, should be, if anything, on the increase, is one of the unsolved mysteries of our bird life.

The banded dotterel pack into flocks from December onwards, the adult birds moulting into their winter plumage as soon as their nesting operations are over. Most of them migrate to the South-eastern portion of Australia for the winter, but they do not nest there, the birds returning to New Zealand in August. They are then in their full breeding plumage and some are already paired for nesting, which is in full swing in September.

The Wry-billed Plover *(Anarhynchus frontalis)* is gradually being driven from its nesting haunts on the bare shingle riverbeds by the growth of exotic plants, particularly lupins, thereon, but its numbers seem to be much what they were twenty-five years ago.

A few wry-bills leave the river-beds as soon as the nesting season is over, going to the shores of Lake Ellesmere and similar places where they consort with the dotterel and other plovers. The adults moult into their winter plumage, and by the beginning of April, practically all of them have left for the north of the North Island, where they spend the winter. Like the banded dotterel, they return early in August, and begin nesting forthwith, the first young birds appearing in the last week of September.

The Pied Stilt *(Himantopus picatus)* is very numerous, especially around Lake Ellesmere, the Washdyke and similar lakes, but it is almost completely gone from the riverbeds which used to be favourite nesting-grounds. This is, no doubt, due to its being shot there during the nesting season by irresponsible gunners who go out primarily after rabbits. This last, is also the reason for the decrease in the number of Pied Oystercatchers *(Haematopus longirostris)* that nest on the riverbeds.

The Black Stilt *(Himantopus melas)* is now very scarce, though it occasionally occurs, usually as single birds which mate with pied ones.

The stilts leave the South Island in April, and early May, very few birds remaining here over the winter. As to whether some of them leave New Zealand altogether, I do not know. They return to Canterbury with great regularity at the end of July, and begin nesting in the latter half of September.

The Shore Plover *(Thinornis novae-zealandiae)* I have never seen in Canterbury.

The migrants are probably in much the same numbers as formerly, though the Godwits *(Limosa novae-zealandiae)* and Knots *(Tringa canutus)* for which there is an open shooting season, seem to be forsaking Lake Ellesmere to some extent. This is most likely due partly to the shooting and partly to the great increase in the numbers of the stilts on the Lake during the past twenty years. The stilts, which have been protected for many years now, are in thousands on the Lake, and they must be serious competitors with the godwit for the available supply of worms, larvae, etc., which form the food of both species.

Knot are very common during the summer but none of them ever winter here as do quite a number of godwit.

The Grey Duck *(Anas superciliosa)*, 15 years ago, had been much reduced in numbers by gunners, but has increased considerably since, owing to shorter shooting season, and restrictions as to methods of taking it. The Spoonbill Duck *(Spatula rhynchotis)* is fairly plentiful, and is apparently holding its own. Both of these ducks breed on the River Avon in Christchurch. Every year when the shooting season opens, great numbers of ducks flock into the sanctuaries, even in the middle of towns, as in the domains at Christchurch and Ashburton.

The Blue Duck *(Hymenolaemus malacorhynchus)* is getting rare in Canterbury now, and is only to be met with in the most inaccessible creeks.

The Brown Duck *(Elasmonetta chlorotis)* is almost, if not quite, gone from the province. Black Teal *(Fuligula novae-zealandiae)* are practically gone from Lake Ellesmere, and seem to be decreasing everywhere except on one or two back-country lakes. About twelve years ago the Acclimatisation Society established a

few on the Avon in Christchurch, where there are now about two dozen birds. They do not increase much, though a few are reared every year.

The Paradise Duck *(Casarca variegata)* is still plentiful in most suitable localities, and, with proper restrictions on shooting, it should remain so. When totally protected, it increases rapidly in numbers.

Among the gulls and terns, the Black-fronted Tern *(Sterna albistriata)* is the only one whose numbers have diminished. In the early days there were several nesting sites out on the plains to which these terns used to repair in great numbers to breed. One of the largest was at Pudding Hill near Mt. Hutt, where hundreds of black-fronted terns nested on a stony patch of ground. Today they nest exclusively in the river-beds. Although their numbers have been reduced, these terns are still plentiful. Besides being exceedingly beautiful, they are very beneficial to the agriculturalist, for when they follow the plough or harrows, the terns feed chiefly on grass-grubs, and wire worms, leaving the lob-worms, which are too big for them. They thus destroy the farmers' enemies and spare his friends. The gulls, on the other hand, especially the black-backed gulls, will take the big worms in preference to the smaller grubs. Black-fronted tern will eat insects whenever they can get them, and it is a very pretty sight to see a flock of these birds "hawking" insects in the air.

During the autumn and winter these terns collect in companies to roost. Near the Waimakariri Gorge there was such a company and it was most interesting to see the birds coming in at sunset. High over the terrace they came; in flocks of five to fifty birds, darting and diving down to their roosting place hundreds of feet below. Every now and again the main flock would rise off the ground and circle around a few times before settling down again. There were perhaps between seven hundred and a thousand birds there altogether.

The Black-billed Gull *(Larus bulleri)* is a very common bird in Canterbury, although Buller and others seemed to regard it as a rare species. It frequents inland as well as the coastal waters, nesting in colonies on the shores of lakes and rivers. Lake Ellesmere is a favourite habitat, and it is not unusual to see there

flocks of black-billed gulls numbering many hundreds of birds. The closely-allied species—the Red-billed Gull *(Larus scopulinus)*—is very rare here, although it is the predominating species, especially on the sea coast, both north and south of us. I have never found the red-billed gulls nesting in Canterbury, but I was told that two pairs of them built on the Opihi River about twenty years ago. The only difference between these two gulls observable in the field is in the colour of their bills and feet, the red-billed having these parts bright scarlet, and the black-billed having the bill reddish black and the feet deep blood red.

An interesting example of adaptation is to be noticed at Lyttelton, where the black-billed gulls now feed at night in the area illuminated by the electric lights on the wharves.

The White-fronted Tern *(Sterna frontalis)* is abundant along the coasts, and colonies, each numbering thousands of birds are to be found in favourable situations.

The Caspian Tern *(Hydroprogne caspia)* is generally distributed on the coasts, and, although it does not congregate in large flocks, is by no means rare. It breeds with us regularly, nesting as a rule near the sea, but sometimes going long distances up the riverbeds for a site.

The Little White Tern *(Sterna nereis)* twenty-five years ago nested regularly at the mouth of the Rakaia River, but I have not seen one of these birds for nearly twenty years now. On the other hand the White-winged Black Tern *(Sterna leucoptera)*, which Buller gives rank as a New Zealand species on the strength of one pair shot near Nelson, is now an almost regular visitor to Canterbury in the summer, and I know of at least one case when they nested here.

The Black-backed Gull *(Larus dominicanus)* is one of those species which are undoubtedly on the increase with us. Sheep farming, the meat-freezing industry, agriculture and the shipping on the coast have all provided the black-backed gull with an augmented food supply and the birds have profited by the abundance. I think it very probable that the increase in numbers of this gull is directly responsible for the decrease in the black-fronted terns, for the gull would rob the

terns' nests of eggs or devour their young, whenever it got the chance. There is a similar case on the eastern coast of N. America, where a large gull has extended its range, and almost exterminated a smaller species in the invaded territory. Two pairs of black-backed gulls which nested near the mouth of the Rakaia some years ago, fed their young almost entirely on the young white-fronted terns and black-billed gulls from a colony nearby, taking their prey, despite the clamour and attacks of thousands of the two smaller species.

Of the birds of prey, all the species still inhabit Canterbury, though the Laughing Owl *(Sceloglaux albifacies)* is on the verge of extinction. Why this should be so is hard to say. It was maintained by early writers on the subject that this owl lived chiefly on Maori rats. If indeed rats formed the major portion of its food, one might have expected it to be on the increase, for the introduced black rat *(Mus rattus)* swarmed over the country while the laughing owl was still fairly plentiful. The last record I know of this owl in Canterbury was about three years ago; but I heard of one that was seen last year south-west of Lake Te Anau.

The Morepork *(Ninox novae-zealandiae)* is not uncommon in bush areas, but does not seem to take kindly to civilisation. It comes to plantations near homesteads in the winter, but rarely stays to breed. A few come to Christchurch in the winter, and several times one has wintered in my garden.

The introduction of the Little Grey Owl *(Athene noctua)* is probably going to adversely affect the morepork, which is much to be regretted, for the latter is much the more useful bird of the two.

The Harrier *(Circus gouldi)* has almost certainly increased since the country has been civilised. It is not a bird that frequents large areas of forest, so the clearing of the bush has been to its advantage. The introduction of rabbits, so detrimental from all other points of view, must have been regarded by the harriers as a very beneficient move, for the rabbit has provided them with an abundant food supply in many districts which previous were almost barren from the harrier's point of view. These hawks take a certain toll of farmers' poultry and doubtless kill a few weak

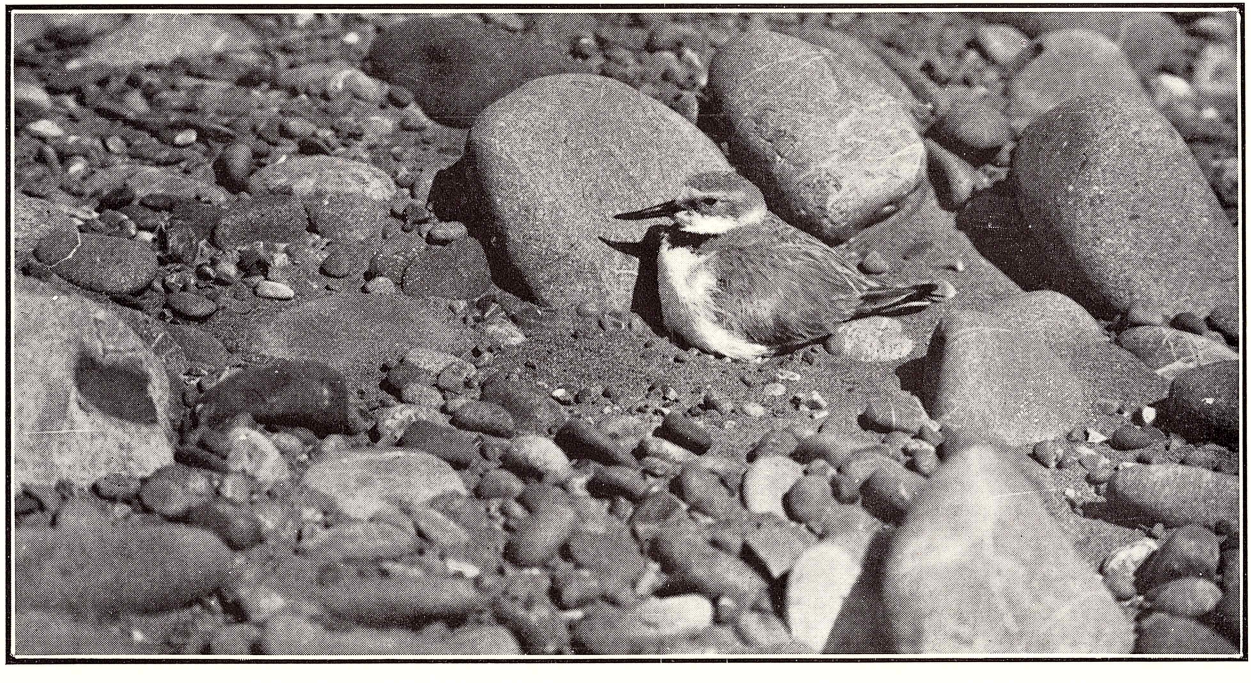
lambs, but, as they are offal feeders, it is very hard to say in most cases whether the lamb was dead or not when the hawk began its feast. Harriers are not beloved by sportsmen, for they undoubtedly kill numbers of young ducks, and other game birds; and the introduction of new species of game birds is made much more difficult on account of the numbers of hawks.

The question as to whether there are two species of falcon or only one in New Zealand is still debated. All the evidence that I have collected indicates that there is only one species in Canterbury; but the opinion of such an expert field-naturalist as the late T. H. Potts cannot be lightly disregarded, and he was firmly of the opinion that there were two species here. The great difference in size between the male and female has no doubt led some observers to declare the birds two different species. In 1910, at the back of Mt. Somers, I saw a male falcon catch a greenfinch and take it to a large flat rock and begin to pluck it. Here he was joined by a female, and together they fed on their prey. That two adult falcons should share the same food is, to my mind, quite incontestable evidence that they are mated. I shot them, and found the male to correspond almost exactly with the smallest measurements of the male sparrow hawk; and the female to be as large as the largest female quail-hawk.

Be there one species or two, these falcons are magnificent birds. They nest on steep hillsides, laying their eggs on the bare ground under an overhanging rock, or bush. They will defend their home against intruders with the greatest courage, attacking and even striking man in their efforts to drive him away. On one occasion when I was engaged in photographing a pair of falcons beyond Lake Coleridge, one of the birds struck my felt hat off, and in doing so, put a rip in it over three inches long.

Musterers' dogs and horses are also fiercely attacked. Twenty-five years ago a pair of falcons always nested among the rocks beside a waterfall on Peak Hill, on the road to Mt. Algidus; but the birds so persistently attacked the horses that were driven past their nest that they had to be destroyed.

I once watched a falcon's nest which contained two



Wrybill on Nest. [Photo, E. F. Stead.

half-grown young. It was placed under a tussock of snow-grass, high upon a steep spur above a patch of beech forest. From the top of a dead beech across the gully, with her feathers fluffed up and her head sunk in her shoulders, the hen bird kept watch, while the cock was away foraging. Suddenly her attitude became all eagerness. I suppose her mate had called to her, though I had not heard him, for he swept round the spur on which I sat, bearing a large lizard in his claws. The hen gave a joyous call and swooped off her perch towards him. They met over the centre of the gully and sailed vertically into the air; he extended his legs with the food in his claws, and she took it in hers; and both turned back—he round the point of the hill again, and she, with a soft crooning cry of gratitude, back to her perch on the beech. There she paused a while, and then flew to the nest, gave the food to the young birds, and immediately went back to her look-out.

Unfortunately, their fine fearlessness has been their undoing, and these falcons are now becoming scarce.

To a large section of the general public the most interesting question in regard to our native birds, is not which of them will survive in the inaccessible parts of the back country, but which of them will be commonly met with in the cultivated, and even in the suburban areas. I have recorded the following native birds in my garden, "Ilam," Christchurch, since 1914: —Grey warbler, fantails, blight-bird, kingfisher, tomtit, long-tailed cuckoo, shining cuckoo, tui, grey duck, spoonbill duck, pukeko, wood-pigeon, bell-bird, black shag, morepork, harrier hawk. The only other bird which I know has visited a garden in Christchurch in the past ten years is the white-throated shag, a young bird of which species stayed in Mr. Chas. Clark's garden, Colombo Street South, for a week some years ago.

Of the birds in the above list, I think it probable that the fantail, grey warbler, blight-bird, kingfisher, tomtit, shining cuckoo, grey and spoonbill ducks will continue to thrive in contact with civilisation, wherever conditions are suitable, and adequate protection is afforded them. I see no reason why the pigeon should

not become resident in our towns if it were not destroyed. The tui and the bell-bird, particularly the latter, may become breeding residents in our gardens, and enhance the charm of them with their beautiful song. The rifleman, too, may return. The pukeko can be established anywhere near water, but, handsome bird as it is, its bizarre ideas on gardening render it undesirable so far as suburban gardens are concerned. One may hope that the black-billed gull will adopt the same habits as its red-billed relative in Auckland, and become common throughout the towns, sitting on the house-tops, or picking up scraps in the back-yards. The parrakeets, if they should again become numerous in the bush, would doubtless pay periodic visits at least to the towns, but highly specialised birds such as the crow, thrush, bush-wrens, and saddleback, will never, I think, be able to live outside the areas of bush, and it is doubtful if they will be able to survive even there.

The following European birds are common in Canterbury, the order of the list giving them in approximately their order of abundance: House Sparrow, Starling, Greenfinch, Thrush, Blackbird, Yellow Hammer, Goldfinch, Redpoll, Chaffinch, Hedge-sparrow, Sky-lark, Cirlbunting, Little Owl.

The House Sparrow is truly well-named, for where there is an inhabited house, there also is the sparrow, yet far removed from habitations one never sees him. The sparrow occurs in enormous numbers in Canterbury.

In 1890 T. W. Kirk read a paper before the Wellington Philosophical Society, in which he says: "I have examined a great many nests, but never found less than five eggs under a sitting bird, more often six and frequently seven." I can remember reading this paper when I was a boy, and the figures given did not in the least agree with my own observations. At that time I collected sparrows' eggs and kept them on strings. I have found seven eggs in a sparrow's nest to be extremely rare; six to be quite unusual; five or four to be the usual numbers, with the later predominating, while three is much more common than six. In December this year I went around the creepers on my house and pulled out sixteen sparrows' nests and

examined the contents. Only one had five young, and one had five eggs, the rest had either four or three. Nor have I ever found in Canterbury a case of a sparrow's nest with young and a new clutch of eggs in it at the same time, as related in the above paper. If the sparrows ever bred in Canterbury in the manner attributed to them by Kirk, they have certainly not done so for the past thirty years.

The damage that a severe storm can do to birds is well illustrated by the following. About twenty years ago a heavy southerly gale, accompanied by rain, occurred at Christmas and continued for two days. At the end of that time, I examined the sparrows' nests in some stunted bluegums in an exposed situation, near the mouth of the Rakaia. Of some two dozen nests, only one had live young in it, the rest containing deserted eggs or dead young.

The Starling also occurs in great numbers here, collecting in special roosts in the winter in flocks of thousands. They are pugnacious birls, and will dispossess even kingfishers of their nests. They will also occasionally take charge of the nest boxes of domestic pigeons, driving the rightful owners off. Starlings' nests are almost always infested with lice, to an extraordinary extent, yet the young do not seem to be seriously affected.

The Greenfinch is very plentiful in Canterbury.

The Song Thrush and Blackbird are about equally numerous, and are to be found throughout the district wherever there is scrub or bush, even up in the ranges, at high altitudes. I well remember finding my first thrush's nest at Strowan in 1890. Curiously enough, thrushes had been common there for some years then, though I had never heard or seen one at St. Albans, less than a mile away.

The Goldfinch is found commonly throughout the Province, in town and country.

The Chaffinch is very generally distributed throughout Canterbury, being found in both town and country. It is to be found in numbers in the beech forests up to their altitudinal limit.

The Hedge Sparrow, like the chaffinch, is widely spread and may be found in the mountains, as high as there is any scrub or fern to shelter it.

The Redpole is very plentiful and is now well distributed. The first redpole's nest I ever found was in the Waiau Riverbed above Culverden in 1897. The bird was then common there, though it was some years later before I saw it near Christchurch.

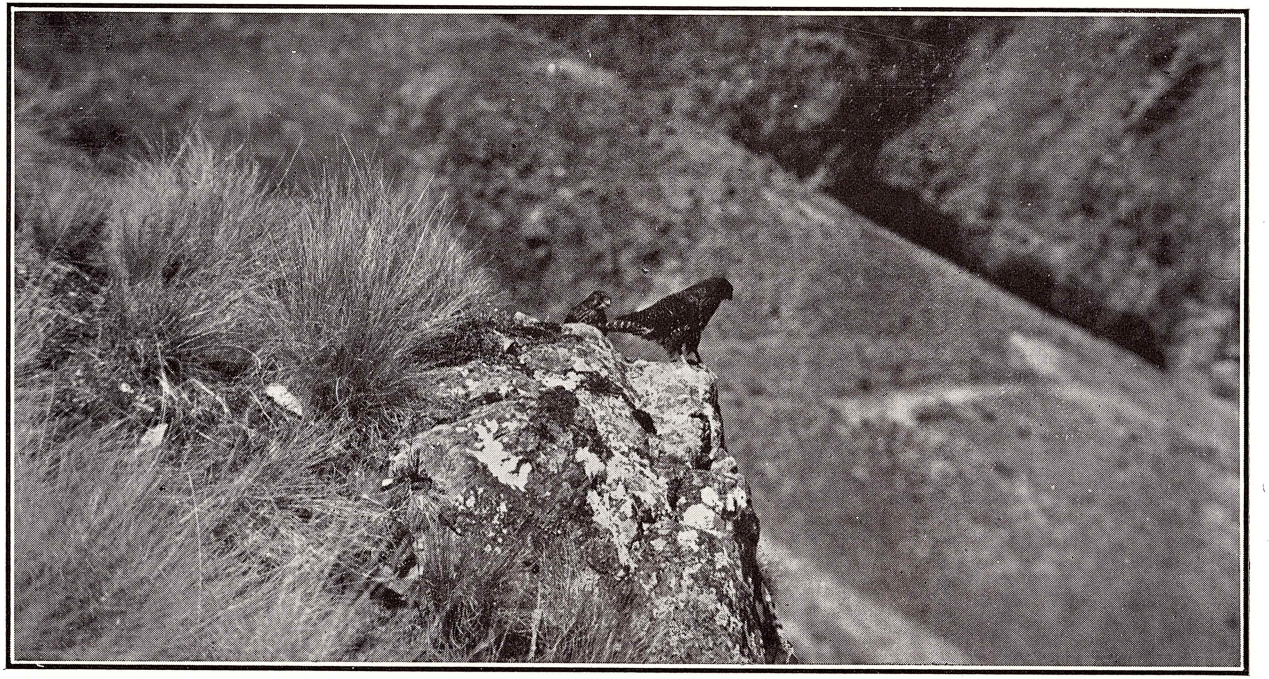
The redpole is the only bird, so far as I know, that eats the "golden oak scale"—the parasite which does so much harm to the oaks in Canterbury.

The Yellow Hammer is to be found in large numbers throughout the Province, outside the towns. It is very much more numerous here than the Cirlbunting, although at the Featherston Military Camp in 1917, these two buntings used to come, in about equal numbers, to feed at the stables. Here, the cirlbunting is by no means common.

The Rook is firmly established in Christchurch, where there is now a rookery of perhaps a thousand birds. They do not appear to spread far of their own volition, the only other rookery I know of in Canterbury being at Mt. Peel, where there are a few pairs of birds which were taken there by Mr. Dennistoun. Around Christchurch the bird is much in evidence during the breeding season, when collecting food for its young. When the latter can fly, they accompany their parents on bird-nesting expeditions, the victims being mostly sparrows, whose nests they tear to pieces, devouring the eggs or young to the accompaniment of the most ecstatic cawing.

The rooks have hitherto nested almost exclusively in bluegums *(Eucalyptus globulus)* in Christchurch. At first they nested in the extreme tops of the trees, but the heavy winds so often dislodged the nests or their contents that the rooks took to building on more solid branches. Owing to diseases, the bluegums are rapidly dying out, and the rooks are now being forced to take to other trees, and are already occupying some pines at Middleton. I have never known them to nest here in either oaks or elms, their favourite trees in England.

The Black Swan is one of the outstanding instances of successful acclimatisation. It is extraordinarily numerous on Lake Ellesmere, where the local Acclima-



Sparrow Hawks. [Photo, E. F. Stead.

tisation Society collects eggs for the market. In 1926, no less than 2500 dozen black swans' eggs were taken from this lake.

The Canadian Goose, first introduced in 1907, is now a well established bird in Canterbury, where it numbers several thousands. For the past two years there have been short shooting seasons for these geese, but the birds are exceedingly wary, and very few are shot.

English Pheasants, which were once plentiful in Canterbury, are now rare, but Californian Quail, though not so numerous as they were twenty years ago, are still plentiful.

The White-backed and Black-backed Magpies *(Gymnorhina leuconota* and *G. tibicen)* of Australia are established in Canterbury, the former being much the more common. Of all our birds these seem to have been the most affected by the electric transmission lines, for I have had numerous reports of dead magpies being found at the foot of the power poles, the birds having in some way "shorted" the lines.

The Acclimatisation of Fish in Canterbury.

With three plates.

By M. H. Godby.

A love of Nature and of sport seems to have been a characteristic of the early settlers in Canterbury and this found expression in the formation of the Canterbury Acclimatisation Society in May, 1864. The Provincial Council made a grant of land and £1000, which latter seems to have been expended in fencing, planting, and generally improving and laying out the grounds, part of which are still occupied by the North Canterbury Acclimatisation Society.

The question of stocking the rivers with salmon and trout soon received attention. In September, 1864, a motion was passed for the purchase of some tanks for transporting the ova when available and on the 6th October a cheque for £15 in payment was signed. About the same time the Society was instrumental in obtaining a grant of £300 from the Provincial Government "to be placed at the disposal of the Tasmanian Salmon Commissioners in aid of the efforts made by Tasmania to accomplish the introduction of salmon and other English fish—an undertaking of great importance to these Colonies." Very wisely no attempt was made to import ova direct from England; the slender resources of the Society were better employed in assisting the efforts being made in Tasmania.

The history of the introduction of salmon and trout to Tasmania is therefore the first chapter in the history of their introduction to Canterbury, and as it is perhaps the greatest and most successful piece of acclimatisation work that has ever been accomplished, the facts are worth recording.

The first attempt was made in 1852: it cost £300 and ended in failure. Two facts emerged from this experiment as of paramount importance: first the necessity for shielding the ova from the slightest concussion, and, secondly the maintenance of a low

temperature throughout the voyage. Considering the shipping facilities of the period these two conditions appeared to present an almost insurmountable obstacle: indeed this was the view of those best qualified to express an opinion.

Fortunately, however, Tasmania had found in Mr. T. A. Youl a man who was not easily discouraged. In 1854 he started a study of the artificial propagation of salmon and transport of ova, and was much interested in the French method by which ova were sent long journeys packed in damp moss, in earthenware jars covered with perforated parchment. He was told, however, that ova would not travel thus, unless so far advanced towards hatching as to exhibit the eye of the embryo fish—technically known as "eyed ova." This seemed to rule out the French method for a voyage half round the world and Youl apparently discarded the idea for the time being.

Youl's first shipment of ova was made in the *Sarah Curling* sailing from Liverpool on the 25th February, 1860. The method adopted was similar in its main essentials to the first shipment—that is to say an attempt was made to keep the ova in a continuous stream of iced water. The passage was long, the 15 tons of ice melted, and the last of the ova died about 30° south of the Equator, when the ship was 68 days out.

After this failure the Governments of Tasmania, Victoria and Southland (New Zealand) combined to make a further attempt and delegated the conduct of the work to Youl.

In view of the fact that in his previous experiment the ova had been carried as far as 30° S., Youl was hopeful that with an improved apparatus he could succeed on the old lines and adopted the same principle for the bulk of the shipment. Fortunately, however, in spite of the opposition of all the leading experts he still retained some faith in the French method of packing in damp moss, and, as an experiment, a pinewood box with walls one inch thick and measuring about 11 inches by 8 inches by 6 inches, perforated top, bottom and sides to allow free passage of water, with 300 ova packed in living moss was embedded in a mass of ice. The *Beautiful Star* sailed on the 4th March, 1862, with

80,000 salmon ova in charge of Mr. W. Ramsbottom. Once again the slow voyage and the heat of the tropics proved too much, all the ice melted by the 17th May just after the ship had reached 22° S. being then 74 days out. One significant fact, however, emerged from this experiment. The ova packed in moss survived longer than any of the others and pointed the way to success.

After this experiment there was a good deal of hostile criticism of the alleged waste of public money, and but for the advocacy of Sir Robert Officer, Chairman of the Tasmanian Salmon Commissioners, all further attempts might have been abandoned. It was eventually decided to make one more attempt and Youl accepted the responsibility on condition that he should have supreme authority.

The significance of the box of ova packed in moss was not lost sight of and a series of experiments was made in the vaults of the Wenham Lake Ice Company. These experiments brought to light three hitherto unknown and encouraging facts; first, that a continuous and full stream of water is not essential: secondly, that partial deprivation of air is not fatal: and thirdly that light is not necessary. Boxes containing ova packed in moss were covered with blocks of ice 2 feet thick and the whole buried under 2 feet of sawdust. After 67 days some of the boxes were opened and the ova found to be alive and healthy. Other boxes were allowed to remain 120 days and still the ova proved to be healthy and the moss growing. The temperature was about 32° F. the whole time, and eventually a fair proportion of ova hatched from each set of boxes. With these results before him Youl was confident of success if only the ice would last throughout the voyage.

The next shipment sailed per the *Norfolk* on 20th January, 1864, and comprised 100,000 salmon ova and 3000 trout ova packed in moss in boxes on the floor of a specially constructed ice house with ice to the height of 9ft. in cubical blocks piled on top. The ice house was sealed before the vessel left, as Youl was determined to have no interference until the precious cargo arrived in Australia. On the 15th April the *Norfolk* arrived in Melbourne harbour. On opening

the ice house it was found that three fourths of the ice remained and a very large proportion of the ova in a box tested proved to be in splendid condition. The bulk of the ova was transhipped to Hobart and on the 20th April, 91 days after shipment, the ova were placed in the hatching races on the River Plenty. On the 4th May, 1864, the first trout hatched, followed on the next day by the first salmon.

After ten years Youl's labours had been crowned with success and there was every justification for believing that it was only a matter of time before salmon and trout would be firmly established in all suitable rivers in Australia and New Zealand. So far as trout are concerned these anticipations have been fully realized and it is questionable whether there is any feat of acclimatisation which can compete with that accomplished by Youl. With salmon, however, another story has to be told. The young fish flourished and descended to the sea as smolts and were never seen again. This was the history of the first shipment and it has been the history of every shipment since, whether to Australia or New Zealand, until quite recent times. What appeared to be the major difficulty of transporting ova 12,000 miles by sea through the tropics, of hatching the ova and rearing the young fish to the smolt stage was solved in 1864, but it was more than half a century later before a sea-run salmon of undoubted authenticity was reported from any river south of the Equator, and this despite the fact that hundreds of thousands of fry, yearlings, and smolts had been liberated in New Zealand waters. So far as Canterbury is concerned *Salmo salar* has not been acclimatised. It is doubtful whether one specimen has been taken in Canterbury waters and such success as has been attained is confined to the Waiau and its tributaries in Southland.

The first trout ova to reach Canterbury were a consignment from Tasmania in 1867 of about 800. These were placed in the Acclimatisation Society's races in Christchurch. Only three hatched and all escaped during a flood. However, two were subsequently recaptured and in reporting on the event a member remarked, "Well may we look upon it as a success, for if these are male and female, there will be

sufficient ova to stock all our rivers in a very short time." Surely this sentence displays the indomitable optimism of the true pioneers! Despite their optimism those responsible wisely decided to take no risks and further consignments were obtained from Tasmania through the Otago Provincial Government in the following years. From the 1868 consignment 433 hatched, of which 112 were retained in the ponds for stock, the rest being liberated. From the 1869 consignment 113 were distributed to various streams, of which 12 went to Timaru. The fry commanded a ready sale at £2 a dozen.

The year 1870 marks a distinct advance, as the Society stripped and obtained ova from its own stock fish for the first time; 292 hatched and were all sold at £2 a dozen. Whether these ova were stripped from the original pair reared from the 1867 ova or from the 1868 hatching is not clear, but in view of the small number and the fact that trout usually mature in their third year, it seems more than possible that these were the progeny of the original pair, and perhaps the pious hope that they might prove to be male and female was fulfilled. The Society has in its possession a stuffed male trout captured in the Avon in August, 1874, which it is generally supposed may have been the third member of the 1867 importation which was not recaptured. The fish weighed 11¼lbs. when caught.

In 1871 the Society hatched 1823 fry, which were mostly sold at £10 per hundred; since then an ever increasing number has been reared each year until the present output stands at about a million a year. Besides this, societies have been formed at Timaru, Ashburton and elsewhere most of which play a part in stocking their own streams. The North Canterbury Acclimatisation Society no longer keeps a stock of brown trout in its ponds, having found by experience that ova from wild fish give better results. Stripping operations start in the Selwyn River about the end of May or beginning of June and usually last about three weeks or a month unless interfered with by flood. After stripping and fertilisation, the ova are put aside to settle for a short time, most of the water is then decanted and the ova are put with fresh water into large "billies" inside of which a flannel bag is suspended to

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Plate I.: Photographs of scales from trout.

250

save all concussion. In these receptacles it is brought to Christchurch where it is transferred to the hatching boxes. At the temperature of the Christchurch artesian water (about 54° F.) the ova "eyes" in about 18 days and is then ready for packing. The balance, which is retained for the Society's own use, hatches in another 16 days or so and about a month later the yolk sac is absorbed and the fry are ready for liberation. For the first 24 hours after stripping ova will stand comparatively rough handling, from then until it is "eyed" it is very delicate and the slightest jar is fatal, but the initial 24 hours more than suffice for the transport to Christchurch. Youl was told when he first conceived the idea of sending ova to Tasmania in moss that the ova would not travel thus unless "eyed." For journeys by train, or when handling was necessary, no doubt this was true, but on a long sea voyage carefully packed there was no vibration to do any damage. He was perfectly alive to the danger of vibration and took the precaution of having the lids attached to the boxes by screws so as to avoid the necessity for hammering.

Practically every river and creek in Canterbury is now fully stocked with trout, in some cases perhaps too fully stocked. All, so far as the records show, were stocked with trout from the same original source or sources and yet the environment has produced for each class of river in some cases one might almost say, for each river, a separate race of trout.

Broadly speaking the rivers of Canterbury can be divided into three main classes, (1) Snow rivers, (2) Rain rivers, (3) Creeks. The snow rivers contain a few large trout scattered throughout their course, which appear to be more or less permanent residents, but the angling depends almost entirely on the sea-run-fish, which for the most part are caught at or near the mouths. These are of a large average size, quick growth, and bright silvery white on the flanks and belly, usually with few black spots and no red spots. They would be difficult to distinguish from typical so called sea-trout of England or Scotland. The rain rivers, which for the purposes of this article must be taken to mean rivers like the Ashley, Opihi, Temuka, etc., with shifting shingle beds, for the most part contain enormous numbers of small trout, bright in

coloration, but more spotted, similar to the trout found in rivers of the same class in Scotland. These are fairly well distributed over the last 20 or 30 miles of the course at any rate. In addition there is a considerable population of sea-run fish very similar to those running up the snow rivers, which begin to come in after Christmas. To what extent the smaller fish later develop the migratory habit is not known. That some do is almost certain (vide fig. 5).

The creeks, which must be taken to mean smaller and shorter streams rising on the plains and flowing in comparatively deep and narrow channels between defined banks, contain yet a third type of trout more resembling the trout of the Itchen, Test, and other South of England Chalk streams. They are for the most part non-migratory, darker in colour, more heavily spotted, plumper, and of a larger average size than those in the rain rivers though not so large as the sea-run fish. Thus the history of trout in Canterbury provides a striking confirmation of Tate Regan's view that all the various races of trout in the British Isles which have from time to time been given specific names really belong to one plastic species, showing different characteristics in accord with their different environments. In Canterbury, starting with the same stock, we have developed very passable imitations of sea trout, burn trout, chalk stream trout and possibly some others, and each type is practically confined to its own particular environment. Lake Ellesmere with its tributory streams perhaps requires treating separately, as it is the source of supply of the Society's ova and is in some respects unique. The Selwyn provides an almost ideal spawning ground for trout; Lake Ellesmere provides one of the richest feeding grounds in the world. Add to this that the Lake periodically opens a mouth to the sea, enabling large quantities of fish to escape and thus reduce the danger of overstocking, and it would be difficult to imagine any conditions more favourable to the maintenance of a good stock of large trout. These expectations are fully justified, and there can be few stretches of water in the world which yield such a weight of trout annually for their area as the last mile or two of the Selwyn. Last season one angler caught 245 trout, averaging

5¾lbs. Lake Ellesmere is perhaps the only water in Canterbury where the trout are showing no sign of deterioration.

The back country lakes of Canterbury yield yet another type of trout, somewhat resembling the so-called *Salmo ferox* of the Scottish lochs, large in size, broad of shoulder but not very deep. In some of these lakes, particularly Lake Coleridge, a curious phenomenon is presented. There appear to be practically no fish between a few ounces and ten pounds in weight. One possible explanation is that the fish, once they have migrated to the lake, grow at an enormous pace, reaching ten pounds or thereabouts in one season. Incredible though this may appear, it is borne out by microscopic examination of their scales. (Vide Figs. 7 and 8.) Indeed there is no other reading of some of the scales, unless we assume that in the very deep waters of that lake there is little seasonal variation of temperature and the fish grow uniformly throughout the year until their first spawning check. This, of course, is a possible alternative, but for various reasons seems the less probable explanation.

It will be seen then that starting from the same stock, possibly mixed, as there have from time to time been imported into Otago, and probably into Canterbury, trout from various parts of the British Isles, Canterbury has reproduced in its various waters trout which represent fairly well the different types which are found in similar waters in the British Isles. For the most part the Canterbury fish are improvements on their prototypes, but the resemblance is quite marked and provides an interesting example of the influence of environment.

There has been much talk recently of the deterioration of our trout and although it is difficult to do otherwise than accept it as a fact, there are certain aspects of the question which are inclined to be overlooked and the facts may not be so serious as some suppose. It is very difficult to get reliable data for comparison: very little has been preserved except records of exceptional catches, and these can generally be matched by exceptional catches in these days. The catch of one angler last year in the Selwyn above mentioned would be hard to beat at any period. Records

of failure are seldom preserved and the present angler, disappointed with a poor basket, is prone to turn back over the red-letter days of the past, forgetting the blank days, and to decide that the fishing is not what it used to be. One early record which has been preserved is instructive. In 1890 the R. H. Rhodes Challenge Cup was won by Mr. W. Mendelson with a basket of 55 trout weighing 27lbs., the result of a day's fishing in the Opihi. This is a record of success, and yet the fish averaged barely ½lb., so even in those times there seem to have been days when small fish were the rule. That there are fewer fish caught per rod now than in the 90's is probably unquestionable, probably also the fish are generally smaller, but then the fishing is much heavier and no doubt in many places the fish have caught up with and in some cases overtaken the available food supply. The requirements of irrigation have diminished the flow of waters in some rivers, notably the Selwyn, until there is insufficient water in the rapid portions of the river to provide cover for trout of respectable size. Indeed, it is questionable whether the lack of cover combined with the constant traffic of anglers up and down the banks has not done more to denude the open shingle bed rivers like the Selwyn of their fish than lack of food or overstocking.

Rainbow trout *(S. irideus)*, although introduced in the North Island in 1877, were not imported into Canterbury until 1898, when the Acclimatisation Society got a consignment of 17,000. Since that date there have been annual liberations totalling many thousands. Of recent years the liberations have been practically confined to the back country lakes, as the fish have never established themselves in the rivers of Canterbury. The generally accepted view is that they migrate to sea at an early age and never return. There are a few rainbow trout in the Rakaia near the Gorge, and an odd one has been taken in the Waimakariri, but on the whole the attempt to acclimatise this species in the rivers of Canterbury has been a failure. The same does not hold true for the lakes, especially where the access to the sea is non-existent or difficult. Here the fish have thrived, in many cases they have thrived too well, or the waters have been

too liberally stocked, with the result that some three or four years after stocking the lakes have yielded magnificent fish up to ten pounds and then the food supply has been overtaken, the fish have gone steadily back in condition, and the size has dropped to 2, 3, or 4lbs.

Lake Coleridge has provided an exception. Very few fish, either brown or rainbow trout, are caught there, yet they never seem to increase very much in numbers and there are practically no small fish. Fish of under 10lbs. are very rare. Lake Pearson seems to be another lake which has not yet become overstocked and contains some large rainbows. Each of these lakes has or, in the case of Lake Coleridge it would perhaps be more accurate to say, had, at times an outlet, and this may have provided a means of escape for the surplus stock.

There has from time to time been some discussion as to whether the original rainbow trout introduced to New Zealand were rainbows or steelheads. The best opinion in America seems to be that there is no difference, a steelhead is a sea-run rainbow—in fact, the term steelhead is applied to the sea-run rainbow *(S. irideus)* and the sea-run cutthroat *(S. Clarkii)* indiscriminately and now the steelhead is no more regarded as a distinct species than the British sea-trout; each is simply the river trout which has acquired a different coloration by going to sea.

American Brook Trout or Char *(Salmo Salvelinus fontinalis)* were first liberated by the Canterbury Society in 1889, although ova would appear to have been successfully imported and hatched by Mr. A. M. Johnson, of Christchurch, before that date, and earlier liberations may have been made. Some of the small creeks in the Mackenzie Country and on the way to Lake Heron were at one time fairly well stocked with these fish and still contain them, but on the whole they have not proved a success and are of no importance.

Mackinaw Trout *(Salmo Cristivomer namaycush)*. The Canterbury Society received a consignment of ova from the Government in 1906, from which it hatched and liberated 4000 fry in Lakes Pearson and Grasmere. A few fish have been caught in Lake Pearson, but nothing very large (about 7lbs.), and as scale examin-

ation indicates a slow rate of growth, it seems unlikely that any very large specimens will be taken from that lake.

White fish (*Coregonus albus*). The Canterbury Acclimatisation Society received a consignment in 1878, from which it hatched 12, and the 8 survivors were liberated in a stream flowing into Lake Coleridge. Nothing definite has been heard of them since, but there have been rumours of some small fish, not trout, seen rising round the shore of the lake. These may have been White fish.

Quinnat Salmon *(Oncorhynchus tschawytscha)*. The Canterbury Acclimatisation Society imported a shipment of 100,000 ova in 1876, of which about half hatched, and the fry were liberated in the Waimakariri, Hurunui, Rangitata, Little Rakaia, Avon and Ashley. Another consignment of 50,000 ova was received the following year, which hatched better, and liberations were made in the Waimakariri, Rangitata, Hurunui, Heathcote and Shag Rivers. Some of the earlier consignments still on hand were also liberated in 1877 in the Hurunui, Opihi, Little Rakaia and Ashley.

These appear to be the only liberations of Pacific Salmon *(Oncorhynchus)* in Canterbury until 1901, when the Government started systematically to stock the Waitaki River. Consignments of ova were received in 1901, 1904, 1906, 1907. By 1906 a definite run of these fish had been established in the Waitaki and some were stripped by the Marine Department and the ova successfully hatched. The Canterbury Acclimatisation Society's Annual Report records the capture of a quinnat salmon at the mouth of the Rakaia River in 1908; the fish has been set up and may be seen in Dalgety and Co.'s offices in Christchurch. Another specimen was caught in the Rakaia in March, 1915, and with minor fluctuations the run has increased yearly and the fish have spread north up the coast, establishing themselves in all the snow-fed rivers, and even it is said, crossing Cook Strait to some of the rivers of the North Island. In view of the fact that all attempts to establish this species on the east coast of America have failed, its acclimatisation in New Zealand must be regarded as a notable achievement.

No very large Quinnat have been taken on rod and line in New Zealand up to date; about 40lbs. is the limit, although larger fish have been reported from the spawning beds. Examination of scales seems to indicate that the fish tend to mature a year earlier than in America and that fish of similar size are a year younger. Professor Gilbert confirmed this opinion, but the number of scales examined to date is too small to make any definite pronouncement. If this should prove to be the case it is in striking accord with the conditions prevailing amongst brown trout and Atlantic salmon. Lake Mjösen, in Norway, produces trout equal in size to any New Zealand lake, but they are old fish and have grown at a moderate pace throughout their lives. (Cf. Fig. 9.) The very large trout of our lakes have generally reached very nearly their maximum size within two or three years of migration to the lake. (Cf. Figs. 6, 7, 8.)

The Atlantic Salmon, which now seem to be established in Lake Te Anau, appear to reach a size comparable with the European grilse after a stay of one summer in the sea or lake, wherever their feeding grounds may be, whilst the European grilse has had another year in the sea. The Te Anau fish usually spawns a year earlier and then growth becomes slow. As a result no large salmon *(S. salar)* have yet been caught in New Zealand.

Sockeye Salmon *(O. nerka)*. The Marine Department in 1901-02 imported 500,000, but they were found to be in bad condition, only 160,000 being good when unpacked, and these did not hatch well. Quite a considerable number were eventually liberated in the tributaries of the Waitaki, and the non-migratory race is reported to have established itself in Lake Ohau. A few sea-run specimens have also been reported, but the identification is not entirely free from doubt and in any case they are nowhere common. This is the only other member of the Pacific Salmon which has knowingly been introduced to New Zealand. Anglers occasionally catch fish which differ from the usual run of Quinnat and appear to resemble Coho *(O. Kisutch)*. It is possible some coho ova may have been included in one of the shipments either by accident or design.

Coarse Fish.

Attempts were made in the early days to introduce various coarse fish such as roach, dace, bleak, tench, carp, etc. With the exception of perch, however, all appear to have died on the voyage or failed to thrive on arrival, which is perhaps better luck than the importers deserve. Perch are still fairly common in some of the tributaries of Lake Ellesmere and Lake Forsyth and in various ponds and dams. They do not appear anywhere seriously to have interfered with trout and must be regarded as a good substitute in waters unfitted for trout.

Conclusion.

Many hard things have been said about the Acclimatisation Societies of New Zealand on account of some undesirable immigrants for which they have been responsible, and, although the blame has sometimes been wrongly apportioned, it must be confessed that they have been guilty of many serious errors of judgment. So far as fish are concerned their record is unblemished. They found New Zealand entirely devoid of fresh-water fish with any attractions for the angler, and they have converted it into a country which sportsmen do not hesitate to travel 12,000 miles to visit for trout fishing. The few mistakes they made bore no fruit and were not persisted in. Amongst their successes they may justly claim the brown trout first and the rainbow trout second. Such success as has been attained with Atlantic Salmon and Quinnat Salmon is due to the Marine Department, and it is perhaps still open to question as to whether the introduction of the latter was a wise move. The importations were made primarily with the idea of providing a commercial fishery and canning industry. Whether local conditions of labour will ever permit of this may be doubted, but in the meantime the fish is affording excellent sport for anglers. How long this will continue is another doubtful point. There is always the chance that the fish may become so plentiful that the desire to catch them may be lost, and in the autumn the rivers may reach the intolerable state of pollution with dead and dying fish which exists in some of the rivers on the west coast of America.

4 5 6

Plate II.: Photographs of scales from trout.

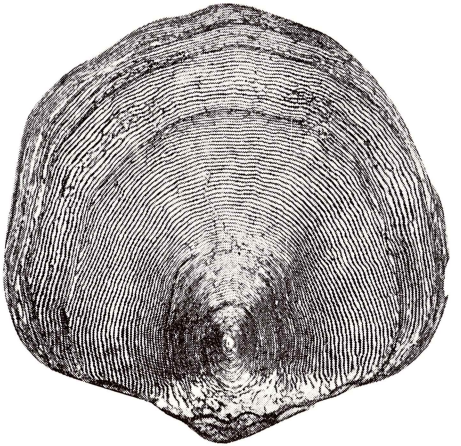

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Plate III.: Photographs of scales from trout.

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The North Canterbury Acclimatisation Society has wisely grasped the fact that little more can be done in the way of importing new species of sporting fish and that practically every stream and lake in Canterbury is carrying a full stock of trout, and has turned its attention towards attempting to improve the food supply of the trout. To do this the first essential is more knowledge, and this means some years of patient research. There is a project on foot now for getting the research work done, and if it comes to a successful issue, it will be the best bit of work the Society has done since it liberated the first brown trout in 1868.

Description of Plates.

Plate No. I. Fig. 1. Scale from a trout of known history, 2 years old. First year in Victoria Lake, Hagley Park. Second year in Acclimatisation Society's Gardens. Length at one year, 5½ inches; at two years, 11 inches.

Fig. 2. Scale from same fish as Fig. 1, taken next year; length, 14½ inches.

Fig. 3. Scale from same fish taken next year, when 4 years old.

Length each winter.	Measured.	Calculated from scale.
1	5½	6
2	11	12
3	14½	14¾
4	15½	15½

Plate No. II. Fig. 4. Scale from male trout caught at Rakaia Bridge, March, 1915; weight, 17½lbs; length, 36 inches; showing regular and continuous growth to an advanced age—probably 11 or 12 years old. Growth of this character is quite exceptional in New Zealand, but may be characteristic of permanent residents in snow rivers.

Fig. 5. Scale from female trout from Opihi River, caught March, 1918; weight 7lbs.; length, 26½ inches; showing 4 years of poor growth in river and 4 years of better growth after adopting a migratory habit.

Fig. 6. Scale of female trout from Lake Marymere, caught December, 1917; weight, 7lbs.; length, 26 inches; showing the characteristic large growth in the second year and slackened rate thereafter;

about 9 years old. Compare Figure 9, a Lake Mjösen trout, which shows a good rate of growth for many years.

Lake Marymere has no tributary streams, therefore the fish must have spent its whole life in the lake. The maximum rate of growth in this lake is in the second year.

Plate No. III. Fig. 7. Scale of female trout from Lake Coleridge, caught March, 1918; weight, 17lbs.; length, 34½ inches. Showing 4 years of very slow growth before migration to the lake and enormous growth in 5th year. About 8 years old.

Fig. 8. Scale of male trout from Lake Coleridge, caught September, 1918; weight, 15½lbs.; length, 33 inches. Showing 2 years' poor growth (possibly 3 years) before migration, and then one year of enormous growth from 8½ inches to 32 inches. The new season's growth is just starting round the edge of the scale. If this is correct reading of this scale it shows a rate of growth which is probably unparallelled anywhere in the world.

Fig. 9. Scale of trout from Lake Mjösen, Norway, showing 4 years' poor growth before migration and 5 years' good, regular, continuous growth afterwards. Length, 86cm.; weight, 9.25kgr. Compare with scales of trout from Lake Coleridge.

Forestry in Canterbury.

By C. E. Foweraker, M.A.

I. INTRODUCTION.

Although Canterbury is chiefly an agricultural and pastoral province and its history is largely bound up with the progress of crop and stock raising, yet forestry has played no unimportant part in the provincial development and it is the purpose of this article to set forth briefly the history of forestry in Canterbury and to give some account of the chief native and introduced timber trees.

The subject naturally falls into two main subdivisions: the native forests or native "bush" and the forests or rather "plantations" of exotic trees. These will be dealt with briefly as a whole and their constituents from a timber tree standpoint will be discussed.

II. THE NATIVE FORESTS.

(1) Historical:

The casual observer cannot but remark upon the scarcity of native forest in Canterbury when compared with other provinces in New Zealand. He would note the odd patches of mixed forest here and there, chiefly in the gullies of the foothills and on Banks Peninsula and would note the larger areas of beech forest clothing the slopes of the main range. Of the native forests of the plains and lower slopes of the foothills but little remains: yet from these and with the aid of reports of the early surveyors and from data supplied by pioneers we can approximately reconstruct the picture of the forest areas of Canterbury at the time of the early settlers in the 'fifties.

Neglecting earlier reports we may confine our attention to that of Davie, Chief Surveyor, who submitted a report to the Provincial Government in 1869. Davie estimated the area of bush in the province

at 270,000 acres of which 46,757 acres had become freehold. The bush on Banks Peninsula was estimated at 64,000 acres, Oxford forest at 56,000 acres, Geraldine 928 acres, Waihi 2,052 acres, Waimate 3,700 acres and Alford Forest 10,000 acres. Scattered patches of bush in gullies were estimated at 12,795 acres and the remainder was given as beech forest on the slopes of the Southern Alps. The total area of the province is 9,604,050 acres so that in 1869 according to Davie only about 3 per cent. was actually forest.

This forest area soon came to be reduced by milling and by fire. Milling commenced early. In 1851 the Provincial Government issued licenses to cut timber and milling operations started at Oxford, on Banks Peninsula, and in several districts in South Canterbury. Fire destroyed much of the Banks Peninsula bush in 1862-3, some 20,000 acres being involved. Milling was active at Woodbury, Geraldine, Waimate and Rangitata; but fires frequently occurred, especially at Waimate where by 1880 milling on a large scale ceased. In North Canterbury milling went on at Kaiapoi and Oxford, ceasing in the latter place about 1908.*

It may be remarked, however, that though large areas were milled and larger ones destroyed by fire, yet the timber obtained was used by the settlers in the development of the province and the land set free, was, in general, used for agricultural and pastoral purposes.

(2) Existing Native Forest:

At the present day the forest areas in Canterbury are few; they can conveniently be placed in two main groups: (1) the beech forest and (2) the mixed forests of podocarps and broad-leaved trees. The former type is almost confined to the main range and to the foothills. The latter type is found in the gullies or at the base of the foothills, on Banks Peninsula, and in one or two isolated spots on the plains of which Riccarton Bush is a notable example.

(3) The Beech Forests:

The beech forest occurs almost entirely in the mountain region, very small areas now extending on to

*From "Canterbury's Native Bush" by A. F. Clark, in "Te Kura Ngahere," Vol. II., No. 1 (issued by Canterbury College Forestry Club).

the plains at Oxford and Mt. Somers, these latter areas having been mostly cut out by the saw-miller. Approaching the more western foothills and the main range the extent of beech forest increases until we find the slopes of the main range heavily clothed with this forest type. The total area of this forest has been recently estimated by Mr. Hutchinson at about 466,000 acres in Canterbury.*

There are two main types of beech forest in Canterbury—the black beech and the mountain beech. The black beech *(Nothofagus Solandri)* occupies only small areas while the mountain beech *(N. cliffortioides)* easily dominates in area. Two other species of beech, the red beech *(N. fusca)* and the silver beech *(N. Menziesii)* occur occasionally, not in pure stands, but here and there mixed with the other species. Such a mixture may be readily observed at Cora Lynn, where red beech is plentiful amongst the dominant mountain beech. All the New Zealand species of beech (popularly referred to as "birch"), are more properly termed "Southern Beech" and are very closely related to the well known genus *Fagus,* the beech of the northern hemisphere.

The black beech is the lowland type, formerly occupying rather extensive areas along the western margin of the plains and forming the Oxford and Alford Forests of the early settlers, but now restricted to very limited areas on the plains at Oxford, Kowhai Bush and Staveley, and on eastern hillsides behind Oxford, Glentui and on Mt. Somers. The altitudinal limit of this species is about 1,200 feet so it does not extend any considerable distance into the higher river valleys.

The black beech sometimes reaches a height of 80 feet with a trunk 2 to 5 feet in diameter. The leaves are $\frac{1}{4}$ to $\frac{3}{4}$ inch long, linear-oblong to broad-oblong with entire margins and a regular more or less pointed base joined to a short leaf stalk. The wood varies in colour from pinkish to yellowish.

The mountain beech rarely exceeds 40 feet in height, being the smallest of the New Zealand beeches.

*The author is indebted to Mr. F. E. Hutchinson, B.Sc.F., for much valuable data on forestry in outlying districts of Canterbury.

The trunk is 1 to 2½ feet in diameter. The leaves are ⅙ to ⅔ inch long; ovate-oblong, ovate or round-ovate with entire margins. The apex is more pointed than that of the black beech and the base is wider, being often unequally heart-shaped. This beech often so closely resembles the black beech that accurate differentiation is difficult. Dr. Cockayne has definitely established the fact that the New Zealand beeches hybridise considerably.

The red beech is a large tree 80-100 feet high and may be distinguished by its much larger leaves broadly ovate in shape and ¾ to 1½ inches long, bright green, thin, and coarsely and sharply toothed.

The silver beech is somewhat smaller than the red beech and has broadly ovate to orbicular leaves ⅓ to ½ inch long with margins having rounded lobes each with a number of blunt teeth.

The black beech has now ceased to figure as a milling timber in Canterbury. Small quantities of red and of silver beech are occasionally used locally for fencing material.

From a forestry standpoint the mountain beech serves as a natural protection forest at the head-waters of the large rivers and its maintenance is an important consideration for the province. Every step possible should be taken to conserve these forests and to encourage regeneration in denuded areas as a safeguard against excessive flooding of the rivers.

(4). The Mixed Podocarp Forests:

Everyone is familiar with the Kahikatea, the Matai, and the Totara, the first two being often spoken of as "White Pine" and "Black Pine" respectively. These trees are not really "pines" in the botanical sense; but belong to a family of conifers known as the Podocarpaceae and consequently are referred to, scientifically as "Podocarps." These three species are usually found scattered throughout a forest comprised chiefly of smaller trees and shrubs with broad leaves, and this type of forest may conveniently be termed the "mixed forest."

From the standpoint of forestry the mixed native forests of Canterbury are of very small value. Typical areas are found in South Canterbury in the gullies, on

some of the slopes, and in some cases at the foot of the hills that extend in this region much further to the east than in North Canterbury. In the neighbourhood of Waimate rather good patches of bush still exist. Other typical areas occur at Mt. Peel and at Mt. Grey. Where areas are not definitely scenic reserves it is doubtful whether they are not slowly but steadily decreasing. On the spurs and gullies and at the foot of the Hunters Hills in South Canterbury splendid areas of bush existed in the early days and much milling went on as stated above. The two chief enemies of this type of forest (as indeed of all New Zealand forests) are fire and stock. Certain areas of gully bush in South Canterbury had been under observation for ten years from 1903 to 1913 and even in that short period of time the diminution in area was obvious. Occasional trees were cut out for farm purposes, stock browsed and sheltered, and the margins were annually invaded by fire during the tussock burns in the adjacent sheep country. The forest floor would also be trampled and seedlings and foliage browsed by stock and the general growth became thinner. The burning of the tussock in some cases causes surface erosion and a baring of former tussock clad slopes. This, along with the gradual depletion of the forest areas was conducive to floods in the gullies which further eroded the forest floor. The general result after the ten years' observation was a distinct change for the worse as far as the forest areas were concerned. One noticeable fact was that several gullies which, at the beginning of the period of observation, always had a stream of water, however dry the season, later on became dry and for the last few years of the period no water during the normal summer periods appeared below a certain point which probably constantly, though gradually, receded. Some gullies became quite dry during the summer. This process is probably going on still and it is a potent factor in connection with floods and river flow and irrigation generally.

The composition of these mixed forest areas is fairly uniform. The largest trees are the podocarps of three principal species—Kahikatea *(Podocarpus dacrydioides)*, Matai *(P. spicatus)* and Totara *(P. totara)*. In rare cases Rimu *(Dacrydium cupressinum)* is found,

e.g. at Mount Grey, but this is a tree requiring heavy rainfall, and one must visit Westland in order to see the rimu forest at its best. Rimu occurred on Banks Peninsula, but has been cut out. Totara and matai occur scattered throughout the gullies, especially at the foot. On the flatter areas at the base of slopes and in creek valleys especially where a tendency to swampy conditions exists kahikatea is found, sometimes in considerable patches. But it must be understood that these podocarps are scattered in the bush—no pure stands of them occur in Canterbury. The vast assemblage of the trees belongs to the broad-leaved type. Space does not permit a full description of this type of forest, but the following is a list of the chief trees and larger shrubs found in the mixed podocarp forest as a whole:—*Nothopanax arboreum* (houhou); *N. Colensoi, Melicytus ramiflorus* (mahoe), *Pittosporum eugenioides* (tarata). *P. tenuifolium (kohuhu), Drimys colorata* (horopito), *Carpodetus serratus* (putaputaweta), *Griselinia littoralis* (broadleaf kapuka), *Pseudopanax crassifolium* (lancewood, horoeka), *Suttonia australis* (mapau) *Fuchsia excorticata* (kotukutuku), *Elaeocarpus Hookerianus* (pokaka), *E. dentatus* (hinau), *Plagianthus betulinus* (ribbonwood, manatu), *Sophora microphylla* (kowhai), *Myoporum laetum* (ngaio), *Aristotelia serrata* (makomako), *Schefflera digitata* (pate), *Coprosma* (various species), *Hoheria angustifolia* (ribbonwood, lacebark, houhere), *Pennantia corymbosa* (kaikomako), *Myrtus obcordata* and *M. pedunculata* (rohutu).

(5). The Chief Timber Trees of the Mixed Forest:

Considering past and present uses the chief "timber trees," if we may so employ the phrase, of the mixed forest are the kahikatea, matai, totara, kowhai, and broadleaf. The two last have been used but to a small extent, for posts piles, etc. The three podocarps will now be described in some detail, as they belong to a fast disappearing forest type in Canterbury.

The kahikatea is really a swamp forest tree. Considerable areas of kahikatea swamp forest existed in the neighbourhood of Christchurch, extending from Riccarton to Papanui.

Pinus insignis, Douglas Fir, and Wellingtonia, Mcunt Peel.

The only remaining portion of this is the Riccarton Bush, which has now lost practically all its former swampy nature, but which in a wet season still gives a good idea of what the swamp forest of Canterbury must have been like.

The kahikatea is a tall forest tree up to 120 feet high and 2 to 5 feet in diameter. It has a tall straight trunk with but little taper. Clean boles 80 to 90 feet to the first branch have been found in good specimens. Its chief characteristic is its buttressed base. Fluted buttresses or flanges surround the base and extend upwards sometimes for 10 feet and a section through this portion has an undulating, almost stellate outline. This basal buttressing is a characteristic of swamp forest trees throughout the world. The reason of these structures is not quite clear, but it may be connected with the aeration of the roots in the swampy habitat. In normal kahikatea swamps such as occur in Westland, the stands are remarkably pure, the trunks running up "straight as an arrow" as Captain Cook phrased it when describing a North Island specimen. The bark is greyish in colour, thick and armour-like and scaling off in more or less rounded flakes leaving corresponding roundish depressions which give the characteristic "hammered" appearance to this tree. In the dry climate of Canterbury the trunk is not thickly covered with mosses and other epiphytes as in Westland.

The crown of the old kahikatea forest trees is roundish and the leafy twigs thereof are whip-like. The leaves are small, about $\frac{1}{4}$-inch long and awl-like. The juvenile foliage is characteristic and totally different from that of the adult. The juvenile twigs are feather-like, the fine, narrow, pointed leaves spreading in a row on either side of the twig and giving it a distinct feathery appearance. The young tree retains this juvenile leaf form through part of the sapling stage and this foliage gradually passes to the adult form. A young potted specimen growing freely has a charming and graceful appearance. The least known fact about the kahikatea, as indeed about all the podocarps is the fact that the tree is dicœcious, that is, one tree is male and another is female. The male bears small cone-like pollen-bearing flowers about three-

sixteenths of an inch long at the ends of the twigs. The female tree, which otherwise is indistinguishable from the male, bears reddish berry-like fruiting bodies. These are, when ripe, about the size of a large grain of wheat, bright red in colour and bearing a small seed at the end about the size of a peppercorn. The female flower from which this fruiting structure arises is a small cluster of tiny greyish scales situated at the tip of a branchlet and requiring a magnifier to be seen clearly. The reddish "berries" are familiar objects where kahikatea grows, and the ground beneath the female tree is thickly strewn with them. The seeds germinate readily and the seedlings are recognised by their four feathery juvenile leaves spreading at right angles from the top of the stem like a cross.

The growth of the kahikatea, like that of all New Zealand podocarps, is slow. Seeds planted in pots and given every care as regards type of soil, moisture and shade, grew into trees only 15 inches high in 4 years.

The totara inhabits the drier and better drained regions. In former days it is probable that totara spread over considerable areas of Canterbury. Some very fine specimens still exist at the foot of the hills, as at Waimate and at Peel Forest. Buried totara logs are often found. The tree reaches a height of sometimes 100 feet with a trunk up to 6 feet in diameter. The trunk branches sooner than in kahikatea and the bark is well known to all—thick fibrous, stringy and peeling off naturally in long strips, capable of being removed in large sheets and suitable for roofing a whare. The foliage is familiar, the leaves being about one inch long, bronzy green, firm and sharply pointed and standing out all round the twig. Totara is dicœcious, the fruits resemble those of the kahikatea but have greener and more pointed seeds. Totara has no marked juvenile form, the young seedlings having foliage closely resembling the adult.

Matai grows to a height of 80 feet with a trunk up to 4 feet in diameter, and flourishes best in rich soil. It branches, like the totara, closer to the ground than does kahikatea. Buttressed trunks are absent. The bark is darker than that of the kahikatea which it resembles in being "hammered," only the markings are smaller and closer together. The leaves are small,

about ½-inch long and narrow. The male flowers are tiny cones arranged in branched bunches and the fruits are arranged many on a stem, being blackish berry-like structures about the size of a pea.

Of the broad leaved trees of the mixed forest having timber value very few need be discussed. The kowhai *(Sophora microphylla)* occurs throughout Canterbury, though large specimens are rare. In every district the settlers have used its wood for posts, house piles and other purposes where toughness and durability were required. A bridge pile has been noted which was quite sound after 40 years. Kowhai may have silvicultural possibilities. The broad leaf *(Griselinia littoralis)* was similarly used, and its value as firewood is well known. The pokaka *(Elaeocarpus Hookerianus)* is likewise commonly found in the mixed forest and makes good fencing material, but the author has so far no record of its being thus used in Canterbury.

III. THE EXOTIC PLANTATIONS.

(1). Historical:

It is extremely difficult to obtain accurate data concerning the planting of exotic trees in Canterbury. Certain it is that the early settlers with their love for, and their memories of, the well planted estates of England adopted the type of lay-out common in the Old Country and planted trees individually and in groups and avenues about their holdings.

No planting with distinct forestry aims seems to have been attempted, at first. Trees from Europe, Asia and Temperate America are to-day found in all parts of Canterbury, giving evidence of the enthusiastic experimental planting of the early settlers.

The first attempts were of an arboricultural nature, a few trees being planted in the grounds of the first homesteads. Some were imported as young potted trees, others were raised locally from seed. Instances are on record where young trees and seeds were imported at a very early date from Australia. Some Australian settlers arrived about 1851, bringing Australian seeds, chiefly blue gum, red gum and wattle, which were planted in many parts of Canterbury. One tree thus raised, about 1851, was on Dr. Barker's pro-

perty near the site of the present Clarendon Hotel in Christchurch. This tree was for many years a well known landmark. Gum shelters were common and settlers often planted a square of gums round their home steads.

At Mount Peel, the estate of the late J. B. A. Acland, many fine specimens of North American trees are found. One of the largest and oldest trees on the estate is a Wellingtonia *(Sequoia gigantea)* imported as a seedling in 1862 from Veitch of Exeter. Seeds of Wellingtonia imported in 1869 were sown and the seedlings planted out. The first attempts to bring out seedlings of Wellingtonia in 1859 failed, the seedlings dying on the voyage. A Douglas fir *(Pseudotsuga taxifolia)* was imported as a seedling in 1859.

Potted trees from Australia arrived in Canterbury in 1864-5. These were Californian trees, chiefly insignis pine *(Pinus radiata)*, Wellingtonia, and Monterey Cypress *(Cupressus macrocarpa)*. It has been related that some of these sold at three guineas each, though certain insignis pine planted at Mount Peel were imported from Sydney in 1863-4 at 4/6 each. A little later seeds of these trees came from Australia. All these species did well and from then onwards Californian trees boomed in Canterbury.

It is difficult, too, to get information regarding the operations of planting in blocks, i.e., plantation making, on the early runs. Mr. Norman Macfarlane, of Christchurch, has kindly supplied the author with the following information concerning early tree planting at Albury Homestead, in South Canterbury: "The first seed sown was that of insignis pine in 1868. Seed was rather scarce so considerable care was taken. Ground was carefully prepared and the seeds were dibbled in about four inches apart and from having so much room grew sturdily. The seedlings were then lined out in a nursery and finally planted out. Some were planted out in holes already dug, but these proved a failure through bad drainage. Those put into land which had been subsoil ploughed proved a great success. In the following year more insignis pine, prickly cone pine *(P. muricata)*, Douglas fir, larch, *Cupressus macrocarpa*, *Pinus ponderosa* and *Wellingtonia* were put in and grew strongly. A few English trees, birch, oak,

sycamore, ash, poplar, willow, and tulip tree were also planted. Altogether about seven acres of mixed conifers were planted about 1870, and the trees now are splendid specimens."

Most of the old established homesteads in Canterbury carried out planting in the seventies, and their efforts are now rewarded in the form of valuable plantations and splendid specimen trees. Some enthusiasts like the late T. W. Adams of Greendale imported seed from all parts of the world and established small arboreta. Shelter belts around homesteads sprang up and at a later date many plantations were put in with a view to a future timber supply.

At the present time the exotic trees may be conveniently classified into three groups: (1) Mixed conifers; (2) English and other broad leaved trees; (3) Australian trees.

(2). The Conifers:

The following are lists of the conifers commonly grown in Canterbury. Trees which are comparatively rare are not mentioned. It must be understood, however, that many of the species mentioned are not grown in quantity for timber but occur here and there for purely arboricultural reasons:

Taxus baccata (yew), *Araucaria imbricata* (monkey puzzle), *A. excelsa* (Norfolk Island pine), *Cupressus macrocarpa, C. torulosa, C. Goveniana, C. sempervirens, Chamaecyparis Lawsoniana* (Lawson's cypress), *Juniperus communis, J. virginiana, Libocedrus decurrens, Thuja plicata, Thujopsis dolabrata. Pinus radiata, P. Laricio, P. ponderosa, P. ponderosa* var. *scopulorum, P. Austriaca, P. muricata, P. Pinaster, P. Strobus, P. excelsa, P. Lambertiana, P. Coulteri, P. Sabiniana, P. Torreyana, P. sylvestris, P. Banksiana, P. tuberculata, P. Pinea. Picea excelsa, P. sitchensis. Abies pectinata, A. nobilis, A. Pinsapo, A. amabilis. Cedrus Libani, C. Deodara, C. atlantica. Larix decidua, L. leptolepis. Pseudotsuga taxifolia, Tsuga canadensis. Sequoia gigantea, S. sempervireus, Cryptomeria elegans, C. japonica.*

Various other species of *Pinus, Picea, Abies, Cupressus, Chamaecyparis* and *Araucaria* exist in parks, gardens and private estates generally, chiefly as

specimen trees. Other species still more rarely found belong to such genera as *Sciadopitys*, *Callitris* and *Taxodium*, but only an odd specimen tree is here and there found.

Of the species mentioned above, the following have been commonly planted in blocks or belts, either pure or mixed: *Pinus radiata* is by far the commonest. Next comes *Pinus Laricio and P. Austriaca* and *Larix decidua*. More recently *P. ponderosa* and *Pseudotsuga taxifolia* have been planted in blocks though these two, especially the latter, are found in old plantations of mixed conifers, among which *P. muricata* and *Cupressus macrocarpa* may be mentioned.

Of the remaining species only a few very small blocks have been planted pure: more commonly these species have been grown in mixtures.

From a forestry standpoint, the majority of all the coniferous species hitherto mentioned may be considered unsuccessful on the plains, though a greater percentage do better on the downs and foothills where the rainfall is greater and the soil moister.

The truly successful tree on the plains is *Pinus radiata*. Next come *P. Laricio, P. ponderosa,* and Douglas fir. *Pinus radiata* is the one pre-eminently successful tree. It withstands the frosts and gales of the plains, where it seems thoroughly at home in the dry atmosphere and porous soil. This tree has done remarkably well on the sandy areas north of Banks Peninsula, thriving quite unaffected by the saline easterly winds and attaining a diameter of 30 inches at the base and a height of 110 feet with a clean milling bole at the age of 37 years. Data regarding its behaviour among the higher mountains are not very plentiful, but there are evidences of its destruction by frost and gales in these regions, but not in sheltered locations.

Corsican pine is grown in most parts of Canterbury but cannot be compared with insignis pine in rate of growth. Its chief merit lies in its hardiness: it can withstand frost and wind better than insignis pine, and in the mountain regions it is easily established. Good plantations exist in the Mount Cook region on exposed situations with rather thin soil.

"*Pinus ponderosa* has been little planted in Can-

terbury though some fair individual specimens up to 45 years of age are to be seen on the foothill estates. Because of its special characteristics in its native country it is now being tried in the severe climate of the Mackenzie Country where drought, high winds, severe winters, and hot summers must be withstood. It is too early yet to pass judgment as these plantations are of very recent date, but the trees show every indication of successful establishment." (F. E. Hutchinson.)

Douglas fir has done moderately well in mixed plantations on the plains. Planted alone the young trees seem to be badly set back by frosting in periodic bad years and though the trees are rarely killed, growth is arrested for the time being. On the foothills this tree does well owing to increased rainfall. Fine specimens exist at Homebush and Peel Forest, where its rate of growth is next to that of insignus pine.

European larch is a well known tree in Canterbury, having been tried in nearly all districts. On the eastern plains in shingly soil it must be set down as a failure. Among the foothills and in districts where the rainfall approaches 40 inches and where the soil is fresh it has turned out very well, e.g., at Homebush on Mr. Jas. Deans's estate. Shelter from prevailing winds is essential. Larch growing on the plains is characterised by a distinct " lean over " from the north-west. At Mount Cook and at Hanmer some good larch is now found, while thriving young plantations exist on Burke's Pass.

Cupressus macrocarpa (Monterey cypress) is also a well known conifer in Canterbury, and has been grown all over the plains as a hedge plant, as a shelter belt and in plantations of mixed conifers. A few pure stands of adult trees have been observed, and small pure areas have recently been planted up. Given good fresh soil it does well, but is somewhat difficult to establish on the dry plains. Its timber is of value for farm purposes and farmers should, where possible, plant up small areas with a view to a good supply of posts, etc.

The Spruces, *Picea excelsa* (Norway spruce) and *P. sitchensis* (Sitka spruce) have been extensively planted but they have been so badly attacked in recent

years by the spruce aphis, except perhaps in one or two regions, that their culture has now ceased.

(3). English and Other Broad Leaved Trees:

The oak, ash, beech, elm, sycamore, poplar, lime, etc., have been planted throughout Canterbury. These are found in small plantations, usually in mixtures. Single trees occur everywhere for ornamental purposes. The larger plantations were nearly all made prior to 1880, and many date back to 1865. All the early settlers planted these trees copiously on their estates, and avenues of oaks, elms, beeches, and poplars are common, while alders and willows have been popular beside streams. The plane, silver birch, lime, and horse-chestnut, are commonly found as ornamental trees, while occasional good large specimens of the Spanish chestnut and the walnut occur.

From a forestry standpoint these trees have not been a great success, although some have possibilities. On the plains the growth of oak is very poor: it is stunted and is prone to insect attacks, especially aphis and the golden scale. In moister situations the tree does much better and is often free from pests.

The two trees that are worth considering for timber production are the ash and the black poplar. Good ash exists on deep, moist soil near Orari, while excellent poplar has been observed in moist hollows at Cheviot and Homebush.

Sycamore has always found a place in estates, parks and gardens, and thrives well and deserves mention here, chiefly on account of its rapid power of reproduction from seed. It even invades native bush, and where stock are admitted, or the soil is moist it grows apace, forming dense thickets and in at least one small area has quite suppressed the native bush. Scenic reserve boards had better be warned to treat this tree like elder and blackberry and briar, i.e., as a "weed tree."

(4). The Australian Trees.

Many species of Australian trees and shrubs have been tried out in Canterbury, but from a forestry standpoint we may consider only two, the eucalypts *(Eucalyptus)* and the wattles *(Acacia)*. Eucalypts have been planted in most districts, especially the

Douglas Fir, planted at Homebush, 1880.

Tasmanian blue gum *(E. globulus)*. Many of the gums tried succumbed to frost, but the blue gum proved frost hardy on the plains and flourished until about 1905, when various insect and fungoid attacks developed. The more robust plantations on better class soils suffered less severely, and most of these recovered.

Of the various other species of *Eucalyptus* tried out, the following have done fairly well: *E. obliqua, E. amygdalina, E. viminalis,* and *E. regnans.* Planting of eucalypts on a large scale is not now carried out as the procedure is considered too hazardous.

Of the wattles many species are found in gardens as ornamental flowering trees, but the only one planted in blocks was the silver wattle *(Acacia dealbata)*. This was planted extensively in the Selwyn district, but is the wrong type for providing tan bark and is little better than a weed tree. It is useless commercially but perhaps useful as shelter for stock. Rabbits, however, often thrive vigorously in its shelter. It is difficult to eradicate, and experiments are being tried with the interplanting of insignis pine in wattle-covered areas. The pine, when it gets away, should certainly suppress the wattle.

IV. CONCLUDING REMARKS.

It will be readily understood that this article has been written chiefly from the forestry standpoint. The arboricultural standpoint has not been unduly emphasised. The limits of space do not allow of as full a treatment as could be desired and Canterbury tree lovers will think of many a splendid specimen tree of some species given but scant mention herein, and be grieved thereby. The æsthetic and sentimental view of tree culture is fully recognised by the writer. Canterbury's trees furnish splendid material for an arboricultural treatise, but this is beyond the scope of the present article, which has aimed chiefly at a brief general discussion of the native and exotic trees which have timber value.

The Agriculture of Canterbury.

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I. HISTORICAL OUTLINE.

1850-1870.

When the province was first settled in 1850 it was almost purely pastoral, and the plains as well as the hills were cut up into sheep runs. Owing to the lack of water for stock all these runs were arranged with river frontages, and as long as there was no water on the plains the land was necessarily held in large blocks.

The Sheep Period of the plains is well described by Mr. Leo Acland in the columns of the *Press* for 1925, and the gradual transition from the Pastoral to the Agricultural phase of the provincial history during the 'sixties and 'seventies is there traced.

1870-1890.

The cutting up of the land into smaller blocks advanced progressively during the 'seventies, and was made possible by the system of water races, which, starting from such smaller rivers as the Hororata and the Eyre, afterwards tapped the main streams and carried their waters to every part of the thirsty plains. This inaugurated the wheat growing era of Canterbury's Agriculture, during which vast areas were sown in wheat year after year, and when wool and wheat were practically the sole exports of the province. The land was often cropped very roughly; one hears of wheat being sown broadcast in September on one furrow out of the tussock. The yields at first were good owing to the accumulated fertility of the soil, but the cropping soon became excessive; part of the land now held by Lincoln College was broken from the tussock and cropped with wheat for 13 years in succession, by which time sorrel had taken complete possession of the soil. The farmers of the 'seventies and 'eighties had no alternative to wheat and wool; the internal trade of the colony was small, and these were the only products that could be exported. The railway policy of the Vogel Government by which lines were laid down in places where they do not even yet pay their way, had this good effect, that it allowed the wheat from the great farms at Methven, Ashburton, etc., to reach the sea-board, and so carried the province over the severe period of depression that followed the orgy of borrowing for which Vogel was responsible.

1890-1915.

With the 'nineties the tide began to turn: the inauguration of the frozen meat trade gave farmers another product to export, and the third phase of Canterbury's agriculture began. Fat lambs were raised as well as wheat; turnips and rape were introduced to support the sheep which were ever increasing

in value, so that rotation of crops became possible; the increasing population of the colony encouraged the development of an internal trade, and the growing of crops such as potatoes to supply the demand of the towns: following the export of meat came the export of butter, so that the richest pasture lands were devoted to dairying; and finally Canterbury became the land of mixed farming such as we know it to-day.

The development along these lines was hastened by the fact that this was the traditional farming of the land from which the colonists had come, as well as by the great expansion in the use of artificial manures which took place in Europe and spread to New Zealand during the later years of last century. The plant foods of the soil depleted by excessive wheat farming were restored by rotations and manures: the somewhat scanty rainfall was made more use of as the principles of dry farming were studied and adapted to suit local conditions: better management of pastures, and the utilization of improved strains of cereals increased production: the somewhat high cost of labour encouraged the employment of labour-saving machinery: better crosses for the production of fat lambs were evolved: prices rose steadily and continuously: so that finally, at the outbreak of war in 1914, the farms of Canterbury had had 25 years of prosperity, and had built up a system of mixed farming that was not only a source of pride and profit to themselves, but a useful example to other provinces whose initial advantages in the way of open country were not as great.

II. CLIMATE.

The rainfall is in general about 26 inches per annum, fairly evenly distributed throughout the year. The sunshine, however, is frequently intense, and hot drying winds are prevalent, so that the evaporation from a water surface amounts to 34 inches a year. Dryness of the soil is therefore the commonest limiting factor in crop production, and this is the more so as the water retaining capacity of the soil is the less. A great deal of the field husbandry is therefore directed towards conservation of soil moisture, and the critical period on most farms is February, when the soil moisture is at its minimum.

III. CLASSES OF SOIL.

From an Agricultural and Pastoral point of view Canterbury is divisible into several areas as follows:—

a. Pastoral Country.

1. The Back Country, consisting of the outlying ranges of the Southern Alps and the intermontane basins. This is by far the largest area, occupying about four and a half million acres: it is still all in the native tussock except for small patches of cultivated lands round the homesteads.

2. The Limestone Hills. These occur in North Canterbury in the regions of Waikari and Stoneyhurst, and in South Canterbury, in those of Pareora and Waihao. Here again the land is still largely in tussock, although the pasture has been greatly improved by the surface-sowing of English grasses.

3. Banks Peninsula, an area of about 200,000 acres consisting of volcanic hills overlaid on their lower 600 feet by loess. Tussock is still largely prevalent, but cocksfoot has thriven amazingly on the volcanic soils, while danthonia is strongly invading the lower slopes on the northerly faces. Round Akaroa Harbour the grass is so good in nearly every bay that dairying is successfully carried on.

b. Agricultural Country.

Under this heading we have to consider more carefully the flat and downy country that is under the plough. The discussion will be arranged under the headings of:—

1. The Plains.
2. The Downs.

1. The Plains.

The Canterbury plain stretches unbroken from Waipara in the north to Timaru in the south, a distance of some 140 miles. Pinching out to nothing between the hills and the sea at either end, it attains a width of about 45 miles in its middle portion, and its total area is about 2,000,000 acres. Detached portions of the plain occur in the extreme north of the province from Hawarden to the Hurunui, and in the south from Studholme to the Waitaki. These detached portions have the same geological origin, and soil characters as the main plain and so will not be further

differentiated. The Waikari flat and the Omihi Valley have, however, soils modified by the greensand underlying the limestone of that district, but this fact does not alter in any great degree their system of agriculture, although it has some effect on the manures used.

With these greensand exceptions the plains are all composed of a rounded gravel whose largest component stones are generally about three inches in diameter, although in many parts stones of twice that diameter are common. This gravel, locally called shingle, is of greywacke transported from the Alps and deposited as a plain. Where the gravel is pure, as in the river beds, it of course cannot be cultivated, but in most places its upper layers consist of a sandy soil, or underlaid by clay, or by clay and peat interstratified, so that various soils are found on the common gravel substratum. No systematic soil survey of Canterbury has yet been made, and so no exact localization of soil types is here attempted.

(a.) The Shingle Plains. Here the gravel or shingle is directly overlaid by the surface soil with no layer of clay between. Thus the rain water runs directly through the soil which dries out completely in hot and dry summers. The overlying layer of soil varies much in thickness, varying from nothing in the river-beds up to six inches on the turnip lands, and the whole area occupies perhaps over half a million acres. The poorer classes are the less important and fortunately the less extensive. They consist of (1) pure river-bed, with no soil, overrun with gorse and lupins, often infested with rabbits, and not susceptible of improvement except perhaps by planting with trees where the rivers are fairly safe. (2) Scrub lands which have a powder of soil, and are found near the Hurunui and the Waimakariri. These are definitely destined for afforestation, and by the end of this year 16,000 acres will have been planted in pines at Balmoral. (3) Poor stony flats with an inch or two of soil, occuring near most of the rivers and carrying either the original tussock, tumatakuri, and heath, or a poor open pasture of introduced weeds, or a dense sward of such low fertility grasses as danthonia. Chewings fescue or brown-top.

The largest and most important section of the

shingle plains is under cultivation for grass, turnips and oats. The soil is about 5 inches deep, and although no clay layer intervenes between it and the shingle a certain amount of clay is mixed with the sandy soil, so that early ploughing, and cultural methods adapted to the conservation of soil moisture allow a certain amount of cropping with reasonable hopes of success. The grasses usually last 2 or 3 years, and form sparse open pastures, highly nutritious and palatable while they persist, but soon needing to be broken up again for turnips and oats.

Land of the type described occupies some half million acres on the plains. Patches are found near the Waipara and Ashley. Large areas occur between the Waimakariri and Rakaia, as at Burnham and Rolleston, Bankside, etc. On the Rangitata banks much of the soil is of this type, which occurs again in patches on the Pareora and in full development at Glenavy at the mouth of the Waitaki.

(b.) The Wheat Lands. This is the class of country for which Canterbury is most famous, and which covers over a million acres of its plain. A layer of clay from about a foot to some scores of feet in thickness has been deposited on top of the gravels, and from this clay the soil is derived. The layer of clay prevents the too rapid percolation of rain-water and so all crops of temperate climates, such as wheat, oats, peas and potatoes are grown to perfection, and produce yields excelled by only two or three countries in the whole of the world. Where large areas of this land occur, villages and country towns have arisen, and their distribution fairly well indicates that of the wheat lands.

(c.) The Dairy Lands. Near their mouths the rivers that laid down their shingle and clay, were dammed into back waters and swamps. A rank vegetation resulted in soils rich in humus, which after natural or artificial drainage retain moisture in near the optimum proportion for plant growth. Thus grass grows luxuriantly on these areas and dairy cows thrive. At the beginning of the century these patches of rich soil were marked by dairy factories or creameries, but most of these are now closed since the home separator and the motor lorry have made possible the centra-

lization of the dairy factories in the towns. The dairy cows in Canterbury number 84,000, and another 100,000 are recorded as being kept for other purposes.

The dairying lands occur mostly near the sea, as for instance at Sefton, Kaiapoi, at Marshlands and Halswell, near Christchurch, at Tai Tapu and Lincoln, at Wakanui below Ashburton, at Orari, and at Milford near Temuka. Three areas near the hills that run on have run dairy factories are Staveley, Russell's Flat and Mt. Hutt, and thousands of farmers on the wheat lands maintain a few cows on their richer pastures, and have their cream transported by lorry to the towns.

2. The Downs.

The Downs occur as low foothills between the mountains and the plains. Over a great stretch of country they are absent, the mountains arising directly from the plains everywhere in mid-Canterbury—that is, between the Waimakariri and the Rangitata. In North Canterbury the Downs are best developed on the slopes of Mount Grey, and in South Canterbury there are over 200,000 acres of down country stretching from Geraldine to Waimate, and reaching out to the sea at Timaru.

The soil is a clay loam overlying a clay that in parts tends to be tenacious and sour. At Mount Grey the clay overlies older gravels, at Timaru an extensive lava sheet, and at Waihao and Pareora Tertiary calcareous deposits, but in no case is the style of agriculture greatly modified by the geological understructure. The land is most closely allied in agricultural practice to the wheat lands of the plains, and contributes all kinds of crops to Canterbury's total output. An indication of some difference between the downs and the plains is perhaps to be found in the fact that a good deal of linseed is grown on the downs north of the Ashley and in the Levels and Waimate Counties, and that swedes are found to thrive south of Timaru.

IV. GENERAL OUTLINES OF CANTERBURY FIELD HUSBANDRY.

There are between 13,000 and 14,000 holders of land over one acre in extent, and the average size of holding is just over 600 acres. This however includes the areas

on the pastoral country, and the average size of the agricultural holding is much less. On a rough estimate it is probable that the average farm on the dairy country is under 100 acres: on the wheat land 250 acres: on the downs 300 acres: and on the gravel plains over 400 acres.

E.G.:—

Average holding in	Amuri . . .	4,435	acres
„	„ „	Ellesmere . .	214	„
„	„ „	Ashburton .	610	„
„	„ „	Halswell . .	93	„

Nearly all the land under discussion is freehold, although the majority of farmers have mortgages of varying size on their lands.

Most of the cultivation is done by horses, of which there are about 55,000 in the province. Tractors are however becoming increasingly common and in certain of the wheat districts three-quarters of the farmers own tractors.

The general farm practice for each of the main classes of soil is outlined below.

(1.) *The Shingle plains.* The poorer areas are left in their native tussock, or, having been ploughed are allowed to run into pure stands of the low fertility Grasses such as danthonia, Chewings fescue or brown-top. On these areas sheep are grazed, and moved to better lands in periods of scarcity.

On the better class land the plough is constantly at work. The pastures consist of rye grass with a little cocksfoot. Red clover shows in the first year or two, and white clover appears spontaneously in good seasons. By the third year these pastures become very thin, and consist chiefly of bare ground and hair grass *(Festuca bromoides)* with scattered tufts of cocksfoot. The land is then ploughed and put into a crop of soft turnips for winter feed, or of rape for summer feed for lambs. After the turnips, rape may be taken, or a crop of oats to be cut into chaff may be secured. New grass will be sown down either alone in the autumn, or with the oat or rape crop. When the summer rainfall is sufficient, grass is sown with the turnips with good results. Typical land of this class sells at figures ranging from £6 to £15 per acre. It is most profitably

worked in conjunction with some wheat and dairy land to which sheep can be removed during the summer droughts.

(2.) *The Wheat lands.* The pastures here again consist chiefly of rye grass, cocksfoot, red and white clovers. Where permanence is desired the cocksfoot is increased and dogstail is added, and where more frequent ploughing is practised, Italian rye grass and red clover are more largely used. In from 3 to 6 years the grass has run out and so the land is ploughed for a crop of rape, potatoes, mangels or soft turnips. After the roots a crop of wheat is taken, and then a crop of oats or barley with which grass is frequently sown to start the pasture off on another rotation. There are endless variations on this rotation, which is of the most elastic nature. Many farmers take wheat immediately after the grass. A crop of peas is often intercalated between two cereal crops, and oats and tares may be grown to give hay for winter use and to smother twitch.

Sheep and lambs are of almost as much value as grain even on to the best wheat land, and much of the cultivation is undertaken for their benefit. In summer they feed on the grass fields, and the lambs fatten on the rape. In winter they have turnips, or autumn-sown Italian rye, or catch crops of Algerian oats or Cape barley sown on the stubble of last year's wheat. The few cattle winter in grass fields into which a stack of wheat straw has been threshed, and in favourable circumstances may receive a daily cartload of mangels scattered over the field. Almost no grass is cut for hay. No cattle or sheep are housed: no farmyard manure is made beyond what is used in the kitchen garden; but nearly every crop is sown with 1cwt. of superphosphate or some similar manure to the acre. A few pigs are fed on the inferior wheat, barley and potatoes but no special crops are grown for them.

This class of land sells for prices varying from £25 to £50 per acre.

(3.) *The dairying land.* Here the grass grows luxuriantly and is quite permanent. Rye grass and cocksfoot, red and white clover, are again the basis of the herbage, but one finds timothy and *Poa pratensis,* and in the wetter portions even foxtail fairly abundant.

A small area will be ploughed each year for mangels or possibly a crop of wheat or peas, and then the new pasture laid down. Some fields are always cut for hay, and this, together with the mangels, keeps the cows during the winter, though usually not in sufficient condition to start the spring to the best profit. There is no housing and little rugging of dairy cows, and there is no artificial feed such as cake. The farmyard manure produced goes into the mangel crop. About half a pig per dairy cow is kept (86,000 dairy cows, 48,000 pigs) and is fed almost entirely on skim milk, with a little barley or pollard or potatoes added as it approaches market condition. Dairying land sells for £60-£70 per acre.

V. THE CROPS OF CANTERBURY.

The following table shows the acreage in various crops on the arable part of Canterbury in 1925-6.

Old Pasture on Ploughed land		2,016,736	acres
New pasture (under 1 year)		27,589	,,
Grasses, etc., cut for seed:—			
Rye grasses		21,653	,,
Cocksfoot		9,206	,,
Red clover		3,458	,,
White clover		4,162	,,
Grass cut for hay, etc. (including lucerne)		20,753	,,
Green fodder (probably mostly rape)		104,000	,,
Turnips		127,000	,,
Potatoes		13,600	,,
Mangels		3,014	,,
Wheat (less than half normal)		123,195	,,
Oats. To thresh	42,328		
To chaff	109,206		
		151,534	,,
Barley		11,968	,,
Peas		6,313	,,
Linseed		7,987	,,
		2,652,168	,,

1. *Grasses and Clovers.* The overwhelming importance of grass in Canterbury is seen in the preceding table, and needs no further emphasis. Of all the varieties used rye grass is by far the most important. In farmer's parlance "Grass seed" means perennial rye. It is usually sown at 20 to 30lbs. per acre in a mixture with cocksfoot and clovers. It lasts from 2 to 3 years on the plains lands, and is permanent on the dairy country. Really permanent strains are difficult to obtain. In good seasons the seed is cut with the binder or stripped, and a fair yield is 40 bushels (of 20lbs.) per acre. Of this and Italian rye nearly 22,000 acres were harvested in 1925-6.

Italian rye is also largely used, where the land is medium to good. It is sown in February, and so provides winter feed, as well as feed next summer. It is put in alone at 40lbs. per acre, or with red clover.

For some years Grant Italian and Westernwolth's had a vogue, but all the seed is now mixed, and no differentiation is made. The seed is usually cut with the binder, and threshed.

Cocksfoot is the next most important grass. It has thriven very well among the tussocks on Banks Peninula and on the limestone hills, as well as on the plains where stocking is light or absent—e.g., on roadsides, plantations and railways. In such places cocksfoot is dominant. In fields it is usually sown at about 4lbs. per acre in association with rye grass and clovers, but on the gravel plains it is sometimes sown up to 12lbs. per acre to give permanent pasture. On the downs it is mixed with dogstail and white clover for a similar purpose. The seed is occasionally cut with the binder, but most of that harvested comes from the Peninsula or from the roadsides, etc., and is cut with the sickle.

Since the seed is taken only as a by-product of the foliage, a good mixture of permanent strains has been secured. The trade in this seed is however falling off owing to the competition of Danish seed which looks better, but which produces less leafy plants than the New Zealand seed.

Dogstail is very often sown at one or two pounds per acre with cocksfoot for permanent pasture on wheat lands and those of a somewhat poorer class.

Timothy is used slightly in the dairy country and foxtail is also very occasionally employed on the heaviest soils.

Chewings fescue has been sown and danthonia has asserted itself on much of the lightest shingle plains country. Here these grasses form a dense sward of herbage that is of very low palatability but which is able to survive the driest summers.

Brown-top *(Agrostis tenuis)* is the common roadside grass on the upper parts of the plains and on the foothills, and the common twitch in the fields of those areas. It is never sown but covers large areas with a dense sward of low palatability. It is generally discouraged by ploughing and sowing better grasses, but steadily re-asserts itself.

Poa pratensis occurs commonly as a twitch, and forms an appreciable portion of some of the old permanent pastures on the better land.

No other grasses have any importance at all.

White clover comes spontaneously almost everywhere, when a moist spring and summer occur. It is not usually sown, or if it is, only about a pound per acre is used. In favourable seasons it is cut for seed and at anything like a sack to the acre it proves the most profitable crop the farm produces. The New Zealand strains are quite unimproved, and so resemble the English wild white clover that has proved of such value at Home.

Red clover is practically always included in mixtures for temporary pasture, from 2 to 4 pounds per acre being sown. It gives a great bulk of feed in its first 2 years, and then dies out. It is often cut for hay in December and for seed in March, but the seed crop is very capricious, since it depends on humble bees, and these depend on the weather.

Alsike is very rarely used, even on the heavy soils which are its natural habitat.

Suckling clover gives a bottom to many a poor ryegrass pasture, and Subterranean clover is beginning to appear, but both of these volunteers have the weakness of providing no feed during the hot and dry summer months.

2. *Wheat* usually occupies 250,000 to 300,000 acres, but its importance has been declining since 1915.

It is usually sown in May but smaller quantities are put in during June and August. The usual quantity is about 1½ bushels per acre, sown with 1 cwt. of super or similar manure. The seed is usually pickled with copper sulphate or formalin as a preventative against Bunt. The commonest variety is Solid Straw Tuscan (70%) which is very resistant to the threshing action of the wind. Then comes Hunters (20%) and Velvet and Pearl (10%). A few other varieties are grown in scattered localities, but they are not separately classified in the statistics. The milling quality of Tuscan is said to be rather low, of Hunters fair, and of Pearl good. Pure strains of all these varieties have been distributed of recent years from the plant breeding station at Lincoln. The total yield for New Zealand is 6 to 8 million bushels of which 80% is grown in Canterbury and North Otago. The average yield is 30 bushels per acre.

3. *Oats.* This is one of the crops of major importance, but it also is declining in area with the increase of motor cars and tractors. The crop is sown on lighter land than that used for wheat, or in a worse place in the rotation where wheat also is grown. Oats are usually sown at 2 bushels per acre, and usually without manure, though it has been shown that manure pays. The crop may be sown in February for green feed for sheep in winter, or in April and May or August and September for a crop. The average yield is recorded as 37 bushels per acre, but this is probably misleading as only about one third of the crops is threshed, the remainder being cut for chaff without threshing. The varieties grown are now practically reduced to three, viz., Garton's Abundance, called simply "Garton's" for sowing in autumn or spring: Algerians (a Lincoln College strain) for green feed or for a crop, sown in autumn: and at a long distance from these, Duns, probably the English "Grey Winter" which are always sown in autumn and are nearly always threshed for horse feed.

Canterbury produces about half the oats grown in New Zealand.

4. *Barley.* About 12,000 acres are grown in various parts of the wheat country. It is sown at about 2 bushels per acre in September or early October.

Most of the area is grown under contract to the maltsters at fixed prices, and the maltsters choose the varieties. These are chiefly Chevalier, Archer and Plumage. The average yield is about 33 bushels per acre, and of the million bushels usually grown in New Zealand Canterbury grows about half.

5. *Peas.* This crop is sown on the wheat land usually in October at 3 bushels per acre. Peas are considered to improve the land but the harvesting is very laborious. The commonest, practically the only, variety is the Partridge pea and the average yield is about 25 bushels. About 300,000 bushels are annually produced in New Zealand, Canterbury's share being slightly more than half of the total. Certain garden peas are grown as field crops, for immediate export to catch the English spring sowing.

6. *Potatoes.* Potatoes are planted in October all through the wheat country. The land is carefully prepared and 3 or 4cwt. of mixed manures are sown. The tubers are ploughed in, being laid in the furrow either by hand or a machine attached to the plough. Two ounce tubers are used and 16 cwt. per acre is a normal sowing. The tubers are dug usually by machine in April or May and are largely exported to Wellington and Auckland. The commonest varieties are Arran Chief and Up-to-date, though scores of others are grown. The average yield is about 5½ tons per acre. The total New Zealand yield is roughly 40,000 tons and of this Canterbury provides about 60%.

7. *Linseed.* Linseed or English flax is grown in a few localities chiefly on the downs near the Ashley and in South Canterbury. The total area is about 8,000 acres and the yield under half a ton to the acre. The stems are not used at all, but only the seed. The crop is cut, harvested and threshed as wheat is, and the seed is sent to Auckland or abroad for oil extraction. A good deal is ground also for special calf foods. Of the total New Zealand yield Canterbury provides over 99%.

8. *Subsidiary Hay Crops.* As mentioned before grass is cut for hay almost exclusively on the dairy lands but these account for a total of 20,000 acres. In contrast with the figures quoted in the preceding paragraphs, this is only 10% of the Dominion total. A

thousand acres or so of lucerne are included in the total, but lucerne is not extensively cultivated in Canterbury except in a few favoured spots. Oats and tares are made into hay to some extent, and yield heavy and profitable crops.

9. *Turnips and Swedes.* Swedes do not thrive in Canterbury except on the downs of the south. Elsewhere they are too severely attacked by aphis. Aberdeen turnips are sown towards the mountains where the rainfall exceeds 30 inches, but the great majority of the turnips sown are soft white varieties such as Imperial Green Globe, Lincolnshire Red and Purple top Mammoth. The greatest area of turnips is grown on the shingle plains and on the wheat lands near the hills, other winter crops being more commonly used on the wheat lands near the sea. They are usually sown on the flat, the rows 14 inches apart, and the seeding about 12oz. per acre. They are fed off *in situ* by sheep in autumn and winter. Good yields vary from 100 sheep weeks per acre to 500 sheep weeks near the hills, but in all cases the crop is apt to be greatly reduced by aphis and diamond back moth.

Of the half million acres of turnips grown in the country Canterbury provides about 25%.

10. *Rape.* This is sown on wheat lands after grass in November and December to provide a fattening feed for lambs after weaning. Many farmers buy store lambs from the hills to fatten them on rape, and it is these lambs by which Canterbury is best known to the English public. The seed is sown in 7 or 14 inch rows at 2½ lbs per acre with super, with generally some dried blood from the freezing works added. The rape is a foot high in 10 weeks and fattens 20 to 30 lambs to the acre in a month in a fair season. As with other crucifers it suffers badly from drought and from aphis and diamond back moth in certain seasons, and so it is frequently sown at intervals of a fortnight or so, that the sheep may be available to feed it off as each block comes to the feeding stage. Rape by its rapid growth assists to control weeds which are fed off before they flower, and is altogether a very valuable fodder plant. It is usually taken after

grass and its rich ramification of roots hastens the decay of the turf and leaves the land in excellent condition for wheat to be sown in May.

The area sown is not disclosed in the statistics but is probably about 100,000 acres. It is characteristically a Canterbury crop.

The seed in pre-war times was all imported, but since then has been largely locally grown with perfectly good results.

11. *Kale and chou moellier:* These are more resistant to aphis and diamond back moth than rape is. They are however less palatable and so are used as a standby for dry summers, and for holding rather than for fattening stock. The area in these two varieties is perhaps 5% of that of rape.

12. *Green feed.* This is the name given to catch crops of Cape barley, rye corn, or Algerian oats sown immediately after harvest to provide autumn and winter feed for sheep. These cereals and Italian rye have largely replaced turnips in the most aphis stricken areas. They are usually sown on wheat or oat stubble after a light ploughing and rolling, and after being fed off 2 or 3 times are sometimes let run to a crop, or are ploughed up in early spring and followed by rape or peas or oats. There is no record of the area used in this way, but it probably exceeds 50,000 acres.

13. *Mangels.* These are grown after grass chiefly in the dairy country or the richer part of the wheat lands. The total area is only 3,000 acres, which is largely due to the expense of thinning and lifting. They are sown in October on the ridge or on the flat, at about 4lbs. per acre of seed, and 3 or 4cwt. per acre of mineral manures. These manures are usually mixed by the freezing works and contain phosphate, nitrogen in the form of dried blood, and potash. There is no experimental evidence of increased yield from nitrogen or potash in any kind of crop grown under New Zealand conditions, but the limiting soil food is almost always phosphorus. Any farm yard manure not wanted for the garden is ploughed in in the preliminary cultivation for mangels.

The crop is horse-hoed and then thinned and weeded by hand. Long Reds and Golden Globes are the best

yielding varieties. The crop averages 40 tons to the acre on the best land, and at less than this yield expenses eat up most of the profit.

Mangels are grown in all dairy districts of New Zealand—for instance Auckland grows 2,000 acres, Gisborne 1,000, Taranaki nearly 2,000, Wellington nearly 3,000, and Otago nearly 2,000 so that while Canterbury produces more than any other province it only yields 20 to 25% of the total crop.

VI. SUMMARY AND CONCLUSION.

Canterbury has 2,500,000 acres of arable land, of which 2,000,000 are level plains and the rest easy downs. On this area the ordinary crops of temperate climates are produced under a system of mixed farming, grazing and cropping dividing the farmers' attention. The productivity as indicated by the average yields per acre, is in most crops exceeded only by England, Belgium and Germany of all the countries in the temperate zone.

Canterbury is the chief crop growing area of New Zealand and provides all other parts of the country with such products as wheat and potatoes. Of the totals produced in the Dominion, Canterbury provides of

Wheat	80%
Oats	50%
Barley	50%
Peas	55%
Rye grass seed	50%
Cocksfoot	95%
Red clover seed	50%
White clover seed	75%
Potatoes	60%
Linseed	99%
Turnips	25%
Mangels	30%

The Acclimatisation of Stock in Canterbury.

By G. H. Holford, B.Sc. (Agric.).

Although usually regarded as the Agricultural Province of New Zealand, Canterbury has played right from the importation of the first cattle in 1839, an important part in the introduction and development of all the principal breeds of livestock—cattle, sheep, horses, pigs, poultry, and if one can include them under livestock—bees.

Unfortunately, the records in regard to the acclimatisation of livestock breeds is nothing like as complete as one would like, which, seeing the outstanding importance of the pastoral industry to the province, is much to be regretted.

The date of the introduction of the first cattle to Canterbury (1839) is well established. There seems to be little doubt also that the Deans Bros. brought the first sheep, in 1843, but information is meagre as to the first shipments of horses, pigs and poultry, both in respect to dates of arrival, men responsible and actual breeds introduced.

What facts the writer has been able to gather on the principal classes of livestock, and to some extent of the breeds, is set down below.

CATTLE.

Captain Cook had cattle on board destined for New Zealand, but they perished before he reached this country. Whilst the Rev. Samuel Marsden is credited with landing the first head of cattle in New Zealand by the ship *Active* in 1814, none of these or their descendants came to Canterbury. A Mr. John Bell took 10 cattle and 102 sheep to Mana Island in 1834.

To Mr. William Barnard Rhodes belongs the distinction of bringing the first cattle to Canterbury, he landing at Akaroa by the barque *Eleanor* in November, 1839, fifty head of cattle (including two bulls), nearly

pure Durham *(Shorthorn)* that he had secured from a Mr. Rust of the Hunter River District of New South Wales. These cattle cost £16 a head and they were left in charge of William Green, after whom Green's Point in Akaroa Harbour is named. (Green got £40 per annum and 10 per cent of all sales over £400 as his remuneration.)

Major Bunbury, who was at Akaroa in 1840 for the purpose of taking possession of the South Island, stated in his report on the proceedings, that Captain Leathart, of Sydney, established a cattle run with thirty head of cattle at Akaroa on the 10th November, 1839.

Leathart transferred his interests to the firm of which Rhodes was a member, and the latter acquired blocks of land on Banks Peninsula. Mr. Rhodes was joined in 1843 by George Rhodes, who took charge of the cattle station of W. B. Rhodes and Coy. Robert Heaton Rhodes, the father of our present Sir Heaton joined them in 1850. (Sir Heaton Rhodes is one of the prominent stock breeders in Canterbury to-day.)

In August, 1852, F. W. Stubbs and eight other men, with one horse, took twenty-eight head of cattle from the Peninsula to the Levels, near Timaru, these being the first cattle in South Canterbury.

At Riccarton in 1840 or 1841, Mr. James Heriot, of Abercrombie and Coy., Sydney, came over with two teams of bullocks and two men servants, and they ploughed up about thirty acres of land—the first land cultivated in the Province. The native rats devoured the first crop produced.

The first breeding cattle—indeed the first lots of horses, cattle and sheep—on the Plains of Canterbury were introduced by the Deans Brothers. The *Lyttelton Times* of August 30th, 1851, places the year of this introduction as 1841, but whilst Mr. Wm. Deans landed in Wellington in 1840 and prior to 1843 had twice seen the Plains, it was not until early in 1843 that he came to Canterbury by Hay and Sinclair's schooner *Richmond* and settled at Riccarton.

Mr. John Deans, who settled at Riccarton with his brother William in 1843, left Wellington for Newcastle to buy stock and arrived back at Lyttelton by the *Princess Royal* on 17th June, 1843, after a passage of twenty-one days, bringing with him sixty-one head of

cattle, three mares and forty-three sheep, all of a good class. Six steers and heifers and one mare were lost on the voyage. It was no easy matter getting the stock home after landing, owing to the hills and the swamps and boggy creeks encountered on the Plains.

In January, 1844, the Deans Bros. had broken in and milked twenty cows, from which they made cheese and butter of excellent quality, which brought a good price in Sydney.

Dr. Monro, who visited the Deans Bros. in March, 1844, in company with Frederick Tuckett, who had come from Nelson to find a suitable area for a Scotch settlement in the South, states that when he visited Riccarton there were sixty cattle, thirty sheep and a few horses on the property, and six acres were under crop. He observed that the cattle were in good condition, the sheep moderately so. The latter were in a confined space to protect them from the wild dogs, which were numerous at that time.

Because of the difficult swamp country encountered between Gebbies Valley and Riccarton, Tuckett decided against Canterbury and finally chose Dunedin as the centre for his settlement. By the time the first four ships arrived (1850) Deans Bros. had three hundred cattle, fifteen hundred sheep and over thirty horses.

In 1847 Mr. John Deans again went to Sydney for stock, and brought over 600 sheep. He made a third trip in 1850, when he landed 8 bulls, 162 heifers, 12 mares, 600 young ewes and 11 first-class rams. He sold wool that year at 1s. 6d. per lb.

Whilst proceeding to Australia to bring back sheep to replace those sold to Mr. C. Watts Russell, of Ilam, Mr. Wm. Deans was drowned in the wreck of the *Maria*, near Wellington, on 23rd July, 1851. Mr. John Deans died in 1854.

The descendants of Mr. John Deans still occupy the Riccarton property, and several members of the family are keenly interested in different breeds of stud stock. As breeders of Shorthorn cattle and Southdown sheep they have long occupied a prominent place in Dominion Stud Stock circles.

Mr. Ebenezer Hay, who with Mr. Sinclair and the two families, came down from Wellington in his own schooner *Richmond* in April, 1843, took up land at

Pigeon Bay, whilst Mr. Sinclair went to Holmes Bay. Messrs. Sinclair and Hay brought two cows and a calf, a few goats, and some fowls with them. They sold the schooner to W. B. Rhodes for ten cattle valued at twenty pounds a head. The cattle purchased were at Akaroa, and it took eight men three weeks to widen the track to Pigeon Bay in order to let the cattle through, so thick was the bush at that time. It is recorded by Mr. Jas. Hay that his father, Mr. E. Hay, carried from thirty to seventy pounds of butter weekly from Pigeon Bay to Akaroa, a distance of thirty miles, over a rough track, and he did this in all weathers for some two years. The butter sold at 2s. 6d. per pound.

Dr. Monro records that in 1844 Mr. Hay had ten cattle and Mr. Sinclair twenty-one. He also mentions that Mr. Greenwood, then at Purau, and one of the early Peninsula settlers, had four horses, fifty cattle and four hundred sheep in that year.

It is interesting to note that the *Bengal Merchant*, the ship on which Mr. Hay arrived in Wellington in 1840, carried one cow, and this was for some time the only one in that settlement, and was naturally highly prized. One chronicles states that cows at that time were worth from £70 to £90 apiece. Very often the ships brought them out freight free in consideration for the milk supplied. The actual costs of landing one bull from England, as given by Chas. Hursthouse in 1861, were:—

Prime Cost	£42	0	0
Provisions and attention .	10	0	0
Freight and Primage . .	20	0	0
Insurance	10	15	0
	£82	15	0

To Mr. Robinson, a Magistrate at Akaroa, is due the credit for bringing out in partnership with a Mr. Smith, some of the first Shorthorn cattle shipped direct from England to Canterbury. Of the two bulls and two heifers shipped only one bull survived the journey. This was in 1850.

The first four ships that arrived in 1850 landed five cows that had endured the voyage. Unfortunately three died shortly after landing. Two of them were

poisoned by *Tutu,* a troublesome plant in Canterbury in the early days, and the other one, belonging to W. G. Brittan, fell over a cliff.

Mr Chas. Torlesse, the surveyor, writing in 1851, puts the number of stock in Canterbury—that is the area under the Association—as 50 horses, 1400 cattle and 17,000 sheep. The fee of a stud bull at that time was £5. He said that there were then six dairy stations supplying twelve tons per year of Port Cooper Cheese. Cheese was selling at 1s. 3d. and butter at 1s. 6d. per lb. in 1851.

After the arrival of the first four ships a regular trade began in bringing over stock from Australia. The prices as quoted in the *Lyttelton Times* of 1851 were from £8 to £10 for cows and bullocks.

Cattle did exceedingly well on the luscious native pastures, and they soon multiplied. Writing in 1861, Chas. Hursthouse states:—"There is a sleek well fed look on all domestic stock. Flocks and herds are spreading from point to point and Canterbury deservedly ranks as the finest pastoral district in either Island."

This writer was hardly so favourably impressed with the breed of cattle of that time, as he says "The original cattle came from Australia, but unlike our sheep they make no pretensions to be of any particular breed. Shorthorns, longhorns, no-horns, a dozen varieties, are so crossed and mixed that Youatt himself would scarce distinguish the predominant strain."

From that time onwards fresh importations were made, and stock was secured in increasing numbers from Great Britain and Australia.

Shorthorn Cattle.

The following notes are supplied by Mr. John Deans, of Riccarton:—

"Among the cattle landed by Rhodes in 1839 were a number of pure Shorthorns from the herd of Potter McQueen, whose cattle were well known throughout Australia for their quality. They were sold by Captain Rhodes to Messrs. R. and G. Rhodes, Hay, and Sinclair, and were renowned for their large frames and good milking qualities. The next importation of Shorthorns were brought from New South Wales in 1843 by Wm.

and John Deans, of Riccarton. These cattle were also of Potter McQueen's blood. In 1849 Mr. Greenwood imported a pure bred bull and cow from England, and they were the progenitors of many good cattle in the Province. Mr. Robinson imported a bull in 1850.

The largest importation of pure bred cattle was made by the Deans Brothers in July, 1850. This shipment comprised 168 heifers and four bulls, and was the foundation of the Riccarton and Homebush herds, from which Shorthorns were supplied to most of the breeders in Canterbury. From this time onward, emigrant ships began to arrive, and they nearly all carried a few cattle, most of which were Shorthorns. In 1852 a large herd of 500 with eight bulls was brought overland from Nelson by Mr. J. S. Caverhill. These were also descended, as far as can be ascertained, from Potter McQueen's cattle, and were sold to various breeders throughout the Province. Altogether, in the twenty years from 1850 to 1870, about 4,000 cattle, most of which were Shorthorns, were imported into Canterbury. Many notable importations have since then been made both from Great Britain and Australia, among the latest being some bulls of the Scotch or Cruikshank type, which have proved so successful in Great Britain and America for the production of early maturing beef.

The tendency at the present time is to specialise by drawing a hard and fast line between the beef and dairy types.

It is very questionable whether this is the best policy to pursue, either in the interests of the breed or of the country as a whole, one of the greatest advantages of the breed being its capacity to produce both beef and milk economically. The Shorthorn is still, in spite of the competition of other breeds, dominant in Canterbury, and is the foundation of nearly all the crossbred herds in the Province. It will, owing to its fine constitution, adaptability, and other good qualities, probably retain its predominance in the future."

The Friesian.

The credit of establishing the breed of Friesian cattle in Canterbury (and indeed in New Zealand)

clearly belongs to the late Mr. John Grigg and his son, the late Mr. J. C. N. Grigg, of Longbeach. The complete story is briefly told by the latter in a letter to an enquirer in 1916 as follows:—

"When in England in 1882 I wrote out to my father (the late Mr. John Grigg) asking him if I could bring out the best dairy cattle in the world, and he told me to bring out Holsteins. I landed at Hamburg where at the time a very fine live stock exhibition was being held, and it was here that I saw the North of Holland Dutch Friesian cattle. I purchased the third prize two-year-old-bull (Taureau) as the first and second prize takers had been very pampered and I thought they would not stand the voyage.

"I then engaged an interpreter and selected good cows from several different breeders in the North of Holland. After purchasing the cattle (one bull and seven cows in calf) I found the ports of England were closed against cattle from Holland, so I had to arrange for the cattle to arrive in the Thames when the New Zealand Shipping Company's sailing ships were anchored in the stream, and the cattle were passed from the small steamer onto the sailing ship. The Dutch Friesian cattle arrived safely in Lyttelton in 1883. The cattle in the North of Holland are quite distinct from the cattle in the South. By nature these cattle are big and robust, very easily reared, deep and long milkers, and fatten very easily when dry."

For many years Mr. Grigg's efforts to popularise his cattle met with little success and it is said that more than once he offered to sell his whole herd. However, the merits of these great dairy cattle attracted growing attention as time went on. A steady demand set in until Longbeach cattle were enquired for from all parts of both North and South Islands and they became so widely distributed that it would be difficult to find in the Dominion today a herd of Friesian cattle the majority of the numbers of which do not trace their descent back to some of the original Grigg importations.

Practically no further importations have been made from Holland owing to the difficulties of the regulations re foot and mouth disease, but many importations have been made from America to the North Island.

The breed in Canterbury is in the hands of careful and experienced men who are paying close attention to the important matters of testing and selection. In every herd, only bulls of known producing ancestry are being used and the keenness of the competition at the A. and P. Shows indicates that type and constitution are also receiving full attention.

Under these conditions it may safely be predicted that Canterbury Friesians will maintain, and even improve upon, the great reputation which the breed enjoys as ideal dairy cattle.

The Ayrshire.

In the *Lyttelton Times* of January 25th, 1851, a superior Ayrshire bull was advertised for sale, so the Ayrshire is probably the earliest of the purely dairying breeds to be represented in Canterbury.

The writer is unable to trace the owner of the first Ayrshire or whence it came. Mr. John Parlane, one of Canterbury's oldest breeders, states that apart from the bull referred to above, the first Ayrshires to arrive in New Zealand were those brought to Southland by the New Zealand and Australian Land Coy., in 1859. From that time onward other importations were made to Southland and Otago and it is principally from these herds that the present day Canterbury Ayrshires have sprung.

At one time the Ayrshire was very popular in Canterbury, it then declined in favour, but of recent years it has once more grown in popular favour with dairymen.

The Jersey.

So far as it can be ascertained, the late Rev. J. G. Bluett, of Leeston, and the late Mr. H. P. Hill were probably the earliest breeders of Jerseys in Canterbury. The writer can trace the introductions by Mr. Hill of three cows in 1878, these cattle having been selected in the Channel Islands by Mr. Hill's father.

In 1882 a bull "Billy" was brought from the Island of Jersey, and it is the progeny of this bull and the cows previously imported that laid the foundation of most of the Jersey herds in New Zealand today.

This breed has shown a steady expansion in Canterbury, and of recent years it has made considerable progress.

The Red Poll.

To Sir Heaton Rhodes belongs the honour of bringing out, over a quarter of a century ago, the first Red Polls to Canterbury, and these were also the first in New Zealand.

Sir Heaton still maintains a high class stud of the breed at Tai Tapu. The breed is increasing steadily in the South in point of numbers.

The Guernsey.

This breed was comparatively recently introduced by Mr. George Gould, and Mr. H. S. S. Kyle, and the number in the province is small.

The Hereford and Polled Angus.

Hereford and Polled Angus cattle have been introduced and have done well in Canterbury, but the writer cannot trace the date they were first imported. Herefords are run on a few hill stations, but Polled Angus cattle have always been in small numbers in the province.

HORSES.

Capt. James Bruce, the first owner of Bruce's Hotel, Akaroa, brought over twenty-three horses from Australia in 1826, but these went to John Jones' station at Waikouaiti, Otago.

As indicated in the section on cattle, the three mares brought over from Australia by Mr. Wm. Deans in 1843 were the first horses on the Plains. Dr. Monro records in his diary that in 1844 Mr. Greenwood of Purau had four horses.

After the arrival of the first four ships horses were eagerly sought after, and shipments were brought over from Australia. The prices in 1851 ranged about £30 a head, but up to £70 and over was paid for first class animals.

The present writer has not, (apart from Mr. Jas. Hay's description of the one horse indelibly stamped in his memory) been able to ascertain the type of horses brought out in the earliest years. In all

probability they were mostly of the lighter breeds suitable more for riding than for draught work. By the end of the first year of the Canterbury settlement there were fifty horses, mostly owned by Deans Brothers.

The First Clydesdale.

The earliest importation recorded in the New Zealand Draught Horse Stud Book, published in 1878, is that of the Clydesdale entire "Canterbury" bred by Mr. Lockhead, a farmer near Glasgow and imported in 1850. This is probably one of the several horses brought out by Mr. Watts Russell on the *Sir George Seymour* in that year. The pedigree is unknown.

Mr. Robinson brought out a mare on the *Monarch* —the same ship that brought his Shorthorn cattle in 1850, but no record can be found as to the breed of the animal.

A Clydesdale mare "Darling" was imported by John Deans from New South Wales in 1850.

Most of the early importations to the South Island were made to Otago where some notable studs were established largely on stock from Tasmania and Victoria. From these studs Canterbury drew heavily in the early years.

Mr. A. Hunter, the Secretary of the New Zealand Clydesdale Horse Society, founded in 1911, states in his preface to the Stud Book that "some of the best show mares and a number of famous entires (Scottish) came to the Colonies and as students of the breed in the Old Land have never ceased to regret the loss of some of these, it will be seen that such an origin was not to be despised."

To Canterbury have come some of the best animals imported and as she has all along drawn on the southern provinces for high class Clydesdales, her studs have been kept up to a good standard.

Suffolk Punch.

Suffolk Punch horses were imported by P. C. Threlkeld of Flaxton in the early 'nineties. This was the only importation of this breed to New Zealand.

Thoroughbred Horses.

The first thoroughbred horses introduced into New Zealand came to the North Island. The early Nelson settlers quickly followed the example of the North Island. They were intensely fond of racing and to satisfy their love of sport of this kind they imported so many thoroughbreds that by 1850 Nelson had become the nursery of the thoroughbred in New Zealand.

The history of the thoroughbred horse in Canterbury may be divided into three periods. The first, beginning with the foundation of the province, lasted until the seventies. It may be called the foundation period and is noticeable for the number of highly bred horses and mares imported from England. The second coincided with the period of financial depression which began in the late seventies and lasted until the beginning of the present century. During this period want of money restricted importations and our bloodstock, meagrely reinforced from abroad, had to depend chiefly on local production. With the advent of the new century prosperity returned and with it came a tide of importation which has never ebbed.

The horse named "Shamrock" was the first thoroughbred stallion imported to Canterbury. He came in either 1851 or 1852. The next was "The Peer" an exceptionally well bred horse, full brother to one very distinguished English racehorse, and half brother to another. The lofty standard set by the importation of "The Peer" has been maintained to the present day with the result that Canterbury possesses some of the choicest strains of thoroughbred blood in Autralasia.

The excellence of our horses may be attributed to various reasons, chief of which is the systematic importation of desirable English stallions and mares. It is doubtful if it could be maintained in any other way. As long as our breeders continue to import wisely and with discrimination there need be no fear that the Canterbury-bred thoroughbred will deteriorate.

SHEEP.

The first attempt to introduce sheep into New Zealand was made by Captain Cook on his second voyage, and was unsuccessful. He brought away two rams and four ewes from the Cape of Good Hope, but by the time the *Resolution* entered Dusky Sound in March, 1773, after a voyage of 117 days, only a ram and a ewe survived, and they were in such a bad state "suffering from an inveterate sea-scurvy" that their teeth were loose, and they could not eat the green food which was given to them. Forster in his Journal states that they "were in so wretched a condition, that their further preservation was very doubtful." However, they must have improved, for considering the country about Dusky Sound too rough and forest-clad for them, Cook took them on to Queen Charlotte Sound, which was entered on 18th May. In his Journal he says:—

"On the 22nd in the morning, the ewe and ram I had with so much care and trouble brought to this place were both found dead, occasioned, as was supposed, by eating some poisonous plant. Thus my hopes of stocking this country with a breed of sheep were blasted in a moment."

According to the Rev. R. Taylor, Samuel Marsden, the first missionary, brought over a merino ram and four ewes from Sydney in the 1820's, but these were landed in the northern part of the Auckland province.

In 1840 some sheep were sent across from Australia to Mana Island, but the first so-called "sheep run" was started in the Wairarapa district in 1844 by Mr (afterwards Sir Charles) Clifford.

Two years later in 1846 in conjunction with Sir Frederick Weld, Mr. Clifford landed sheep at Marlborough and began the first sheep station—Flaxbourne—in the South Island.

However, prior to this, as has been mentioned in a previous chapter, Mr. Wm. Deans in 1843 brought to Canterbury forty-three sheep from New South Wales, and these were the first sheep on the plains, and as there is no record of Mr. W. B. Rhodes owning sheep prior to this, these must have been the first in Canterbury.

In 1843 Deans Bros. clipped 130lbs. of wool from 28 sheep and the wool sold at 10d. per pound.

Dr. Monro states that in 1844 Mr. Greenwood at Purau had four hundred sheep, so he must have run Mr. Deans close in the matter of pioneering the sheep industry in Canterbury.

About the time of the Canterbury Settlement a number of so-called squatters from Australia were attracted to Canterbury and started sheep-farming. At that time, owing to drought conditions sheep were selling in Australia at 4d. to 6d. a head.

By the middle of 1851 seven or eight stations were taken up and in that year Charles Torlesse estimated the number of sheep in the Province at 17,000. The *Lyttelton Times* places the number at the end of the first year of the Settlement as 30,000. In a leader of July 12th, 1851, the *Lyttelton Times* states, "We hope to see not a few of the fifty to one hundred acre pilgrims at the end of a few years investing their profits in the still more lucrative business of sheep feeding."

About this time comparatively heavy importations were made from Australia, Mr. Chas. Sidey being one of the largest importers. Mr. Sefton Moorhouse also brought over shipments. The Macdonalds (Orari), the Wilkins and Joseph Hawdon were other early importers. The losses were often considerable as the small sailing ships often took a month on the voyage. On one shipment 1300 were lost out of 2200. On the other hand sometimes large shipments were made without any appreciable loss. In 1855 Mr. Moore of Glenmark only lost 4 sheep out of a shipment of 2000. The sheep realised when sold at Lyttelton from 16/- to 20/- a head for ewes (Merinos).

The plant "Tutu" caused heavy losses in the early days, and on this question the late Sir John Hall wrote:—

"Among newly landed sheep and cattle heavy losses were sometimes incurred through eating 'tutu.' In the neighbourhood of what is now called Weedons, there were two very troublesome stretches of this noxious plant, which most imported sheep had to cross. If they were allowed to feed or rest there soon after landing, probably half of them would be 'tuted' and lost. The

practice therefore was to give them a good rest before reaching this locality, and then to rush them through the 'tutu' so hurriedly that they could not feed."

The carrying capacity was estimated in the fifties at one sheep to two acres on most of the sheep country. Grazing fees were then 2/6 per score of sheep per week.

The price of mutton was fivepence to sixpence a pound. In February 1851 Messrs R. and G. Rhodes advertised 1000 fat wethers for sale at 5d. per pound for the carcase and 5½d. for the joints.

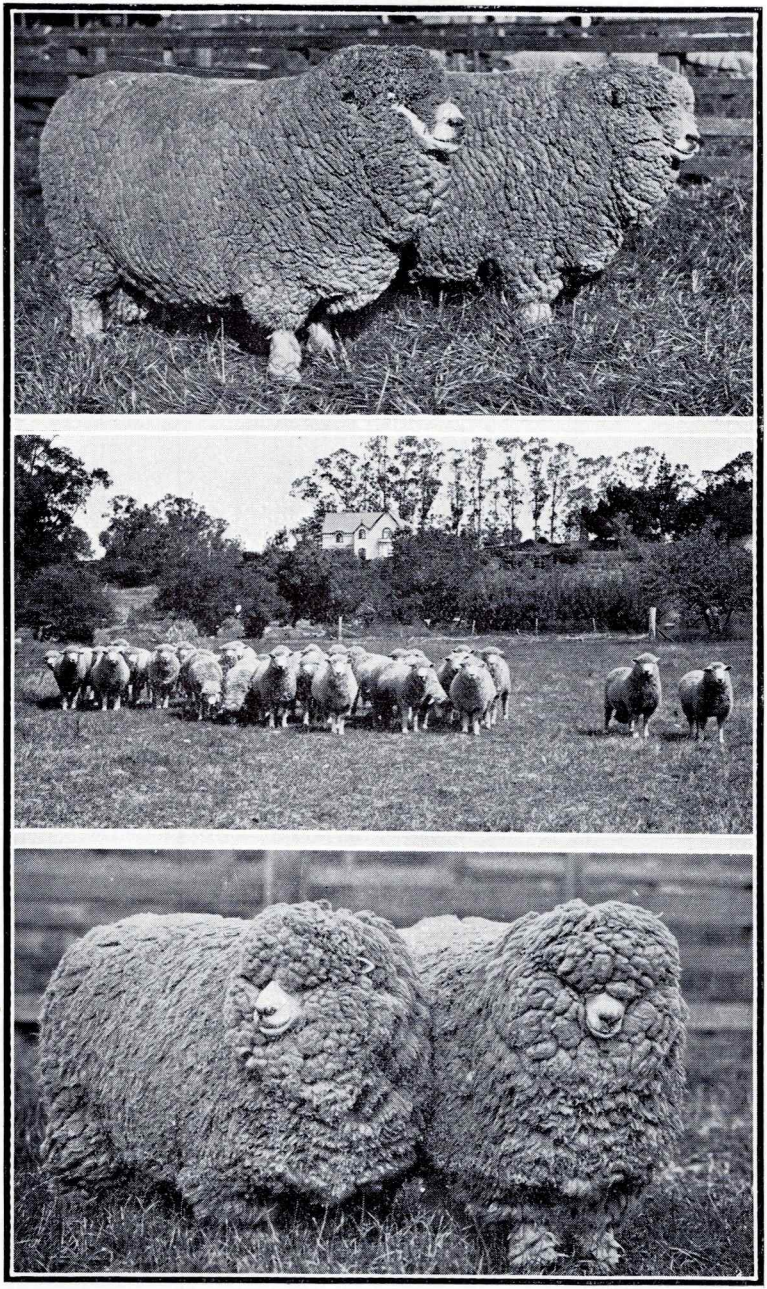
Wool brought around about 1/6 per pound and the weights clipped averaged in those days 3½ to 4lbs. per fleece.

This figure is strikingly low when one realises that high class Merino flocks today average ten to eleven pounds per fleece, but the sheep when they first came from Australia usually shore less than three pounds per head, so that the average weight increased after the sheep had been in Canterbury a year or two. Nearly all the sheep for the first four decades were of the Merino breed, but some had a trace of English Leicester and Down blood in them.

Whilst most of the Merinos were of Australian origin, a few Saxony Merinos from Germany and some Vermonts from America were imported in the early days.

Autumn lambing was at first popular and the average percentage was from eighty to ninety. By 1868 most of the runs had adopted spring lambing, as a few bad winters caused heavy casualities from autumn lambing. The first direct shipment of wool to London was made from Lyttelton in 1860. With 5000 sheep and upwards a yearly profit of 25% under ordinary circumstances was expected.

After the introduction of the "scab" disease, many flocks were tailed by day and yarded at night to guard against infection. A Lyttelton chemist was advertising a dip for scab in 1851. The disease was wiped out from New Zealand over fifty years ago. The only other disease that affected sheep in the early days was foot-rot, which affected the stock when run out under wet conditions.



Corriedales.

When wire fencing came into use the boundaries of most of the Plains runs were fenced and the runs were usually divided into three blocks. A block on water frontage was given to the ewes and hoggets, while the wethers ran on the back part of the run, and did very well, though on many stations they never saw water except when it rained or when they were brought in for shearing. The whole province was fully stocked with sheep, mainly merinos, by about 1870.

In 1870, when the greater part of the Plains had been freeholded, Charles Reed, of Westerfield, made the first water races, and from that time owners of runs and large farms began to cross their merinos with long wool sheep. The establishment of the Frozen Meat trade about 1881 greatly increased this practice. By 1890 the halfbred and three-quarter-bred had driven the merino off the Plains, and from that time began to invade the hills, so that by the end of the Great War a straight Merino flock had become a rarity even in the back country. Since then there has been a tendency in the back country to breed back to the pure Merino. It was while the crossing process was going on that the Province established its pre-eminence in fat lamb breeding, but true half-bred or three-quarter-bred ewes have become increasingly difficult for farmers to get.

The place of the Canterbury bred Merino-Leicester cross has been partly taken by Corriedales and by sheep imported from Otago and Southland since 1900, and in later years from the North Island.

Introduction of Different Breeds.

Of the twenty-four breeds of sheep introduced to New Zealand, fourteen of them first came to Canterbury.

The Merino.

As mentioned earlier the Deans. Bros. had the first lot of Merinos, but the earliest Stud named in the Flock Book is that of Sir John Hall, who started his in 1853, from sheep imported for Mr. Stoddart by Mr. Chas. Sidey.

Mr. George Rutherford's stud was founded in 1866 and was the beginning of the higher class Merino studs existing to-day, it being largely founded on stock secured from Mr. Murray, of South Australia.

With the advent of refrigeration the Merino has declined in popularity and is now only found in the back country stations, and to-day it does not exceed one million or 5 per cent. of the Dominion sheep totals.

The Southdown.

The earliest mention of Southdown Sheep in connection with Canterbury is in a letter written in the forties from Wm. Deans, of Riccarton, expressing the opinion that this breed would prove very suitable for improving the quality of the sheep they then had grazing on the Plains. It was not till the early sixties, however, that any record of the breed in Canterbury is available, the late Henry Matson having imported some from Australia. These sheep were from the flock of Jonas Webb, in England, and were in 1863 acquired by the Deans' Trustees. In 1868 the same breeders imported ewes and rams bred by Sir T. B. Lennard, from the Duke of Richmond's blood; but the breed made little progress then, as mutton in those days played a secondary part in the economics of sheep-breeding, wool being the first consideration.

The advent of the frozen meat trade, however, gave an impetus to the Southdown breed, which is acknowledged by experts to be pre-eminent for quick fattening and high quality of flesh. The number of Southdown flocks registered in Canterbury has risen from two in 1894 to over 100 in 1926, the increase having been very rapid in the last few years; these are used to cross on the North Island ewes that are annually brought down and which are now taking the place of the medium woolled three-quarter-bred ewes which were so successful in the past for breeding fat lambs, but which are now almost unobtainable.

The progeny of the Southdown ram and these strong woolled ewes is a quick maturing lamb with a useful fleece, the fine quality of the Southdown wool counteracting the coarseness of the dam. A large business is done in exporting rams to the North Island for crossing purposes, a trade which is viewed with a certain amount of alarm by those engaged in lamb breeding for export in Canterbury. They believe that

unless the exportation of the pick of the locally bred Southdowns is checked their Province may lose its pre-eminence in the London market.

A Southdown Sheep Society has just been formed (1926), which it is hoped will still further increase the popularity of the breed. The evolution of the Southdown has proceeded along similar lines to those pursued in England, except that rather more attention has been paid here to the wool. The importance of the fleece is now, however, being more stressed in the Old Country, and the lengthy low-set sheep with a good barrel and an even fleece of fine wool is the ideal aimed at by breeders on both sides of the world.

English Leicester.

The English Leicester has all along been the most popular long wool breed in Canterbury. The first of this breed to come to New Zealand was a ram brought by Mr. A. Saunders to Nelson in 1843.

Mr. P. C. Threkeld, of Flaxton, was Canterbury's first breeder, his stud being founded from English and Colonial sheep in 1865.

This breed is holding its own in point of popularity and there are a large number of high class studs in the Province to-day.

Lincoln.

Mr. P. C. Threkeld began this breed in Canterbury in 1865.

There are only one or two small flocks of Lincolns now in Canterbury, and the breed is used largely to supply rams to cross with the Merino to get half-bred sheep. The Lincoln played a prominent part in the evolution of the Corriedale.

Shropshire.

Canterbury claims the first shipment of Shropshires to New Zealand, Mr. C. Williams bringing out four in 1867. Mr. John Grigg founded his stud in 1872.

The Shropshire has rather declined in popularity in Canterbury, more especially in recent years, as the demand for light weight lambs has favoured the Southdown breed.

Border Leicester.

The first Borders came to Otago in the shipments from 1859 to 1862, and most of the Canterbury flocks sprang from these sheep.

However, some early breeders, such as Wm. Boag, imported Borders from Australia in 1865, and Mr. E. J. Lee started a flock from an Auckland stud in the same year.

Border Leicesters are much more popular in South Canterbury than in the North, where they have steadily declined in favour. A heavy demand has recently begun from Australia, and this has stimulated further interest in the breed.

Romney Marsh.

Canterbury's first Romneys were sheep imported by the Bealey Bros in 1867. The New Zealand and Australian Land Company's flock was founded in 1878.

This breed has increased only slowly in Canterbury, but it is easily the most numerous of the breeds and spreads over most of the Dominion, outnumbering all other breeds put together.

To Canterbury came New Zealand's first importations of other breeds as follows:—

Cotswold	1863	Norfolk Down	1868
Dartmoor	1864	Dorset Horn	1897
Wensleydale	1894	Ryeland	1901
Kent	1897	Scotch Blackface	1908
Oxford Down	1904	Suffolk Down	1913
Hampshire Down	1863		

The Corriedale.

Although the first experiments tried in the breeding of the Corriedale were made on the Corriedale Estate, North Otago, these were not a success. The foundation of the present Corriedale flocks was laid in Canterbury. In 1923 the present writer went thoroughly into the history of this breed, and as it is the first breed of sheep to be evolved in New Zealand, a fairly complete historical account may be given here.

The evolution of the Corriedale breed of sheep to a stage at which it is recognised as possibly the finest combination wool and mutton breed in the world is one of the most praiseworthy achievements in the annals

of sheep-breeding. The breed is a living and lasting commemoration of the small band of New Zealand studmasters who stuck resolutely to their idea of producing a breed by cross-breeding long wool sheep and Merinos and of fixing the type of inbreeding the progeny, despite the discouragement they had to face in their self-imposed task.

Origin of the Corriedale.

Although some controversy has ranged round the early history of the breed the facts are reasonably plain, and the story of the Corriedale quite a straightforward one.

It is universally recognised that the first man in New Zealand to cross a long wool ram on to the Merino ewe, then inbreed the half-breeds to secure a new breed of sheep, was the late Mr. James Little, who died some five and a half years ago, and who was undoubtedly one of the finest sheep men of his time.

Just how Mr. Little came to originate the Corriedale is a story of considerable interest. In the early sixties Mr. James Little came out from Scotland in charge of a consignment of Romney Marsh sheep—22 ewes and 9 rams—which went to North Otago to the order of Dr. Webster and Mr. Aitken, who had two properties in this district, one of which was called " Corriedale."

Here it may be well to quote Mr. Little's own words as to the origin of the breed. He has written:—

" This was how the whole affair started. I imported from Home 22 Romney Marsh ewes and 9 rams (Romney) for Dr. Webster, but when his neighbouring squatters met him they ridiculed the idea, stating that the native tussock would not carry the pure bred Romney Marsh. At that time there was no English grass on either Balruddery, an adjoining property, or Corriedale.

Dr. Webster told me that his neighbouring squatters assured him he had made a great mistake in bringing these sheep to this country. My answer was that, with his consent, I would start a half-breed flock provided I could get a few other breeders to start in the same way so that we could exchange rams to prevent the sheep becoming in course of time too sib or inbred.

When Dr. Webster mentioned my proposals to his neighbours and station managers, they and their shepherds went dead against them, ridiculing them in no unmeasured terms, and, as far as I was concerned, nothing but derision was heaped on my head. But as luck would have it I became most successful with the Romney flock, winning a great many prizes and selling rams at big prices, especially in Canterbury. This gave Dr. Webster more confidence, and in course of time he gained courage. He told me he would give me 600 half-bred ewes to experiment with. (This was about 1866 to 1868.)

When we docked the lambs I kept what I thought the best of the half-bred ram lambs to put to the 600 ewes. The ewes had a distinguishing mark, and were put to graze all the winter with the other half-bred ewes. Before lambing, however, they were drafted off so as to lamb by themselves and at docking time the progeny were earmarked and branded, and were grazed with the half-breds out of the Merino eyes until shearing time. They were drafted and compared with the half-breds.

They were shorn separately, the wool was weighed and compared by the wool classers with the wool from the half-breds and inbred hoggets. It was found that their wool had a slight advantage in both weight and quality, and the sheep had a most decided advantage in conformation. It was found also they had fewer of the bad points of the Merino as a mutton sheep.

Let us give honour to whom honour is due. It is evident that had the experiment proved a failure Dr. Webster stood alone to bear the loss, consequently his name should be handed down to posterity as having financed what in those days was thought by one and all, without exception, to be an absurd and disastrous innovation. As time went on, Dr. Webster, being completely satisfied, allowed me to put inbred rams to the whole of the " Corriedale " half-bred ewe flock. On the demise of Dr. Webster, however, all his stud flock was dispersed."

Mr. Little went North, and took up land on his own account at Allandale, in North Canterbury, and, as he says, " I went in for the breeding of Corriedales, neck and crop, and put all my eggs in one basket." This

showed that he, at any rate, had faith in the new idea and later events have proved that this faith was not unjustified. He set to work in 1878 or 1879 to build up a flock, and started out by buying the biggest-framed and sturdiest-looking Merino ewes he could get. The whole of the late Dr. Webster's stud of Romneys and Lincolns were offered for sale about this time, and Mr. Little bought Lincoln rams from this flock and also from Mr. George Sutton, of Southland. From 100 of the best ram lambs, the progeny of these ewes, a heavy cull was made, and twenty of the best were retained for service. These were mated with the pick of the half-bred ewes, the progeny of the Merino ewes and the Sutton and Webster rams. The flock did very well indeed under heavy culling and careful management, and the chief points which worried Mr. Little were a tendency to too much droop in the tail, a rough hip, a weak shoulder, and an aptness to "stand too close." These defects had to be rectified. The ideal that Mr. Little had kept before him all the time was to get the solid well-shaped carcase of a Shropshire or Southdown, well covered with a good staple of the best quality half-bred wool. He also recognised that to make the breed worth while it must be a sheep that would be able to fight for itself and not need coddling, and there was also the point of the lamb to be considered, as the development of the frozen meat trade would make this of considerable importance.

The wool of Mr. Little's flock soon began to be known overseas, and there was very flattering competition for the clip in the market. This led the owner of the flock to make a mistake that he had to rectify later on. He began to top the market, and in his effort to get better and better prices he went on breeding and culling for finer wool, and finer still, until it dawned upon him that if he did not take care he would be getting perilously near the Merino again. The quality of the carcase had not been overlooked in the effort to breed wool, however, and Mr. Little found that the problem that now confronted him was to get a stronger wool back on to his flock.

He was rather handicapped for fresh blood, and at last had to start and breed stronger woolled rams. He procured a score of old Leslie Hills' stud Merino

ewes from Mr. Duncan Rutherford, of the strong Murray type, and also some from the Horsley Downs station, and by this means he overcame the difficulty that had been troubling him, and at the same time obtained a dash of fresh blood that was all to the good, though it did doubtless affect to some extent the stability of the breed, which had been obtained by consistent and careful inbreeding. Mr. Little started a smaller and separate flock with his new ewes, and carefully kept all the strongest woolled rams, which he used on the general flock. This episode took place many years ago, and since that time the flock has been self-contained, with three exceptions, though shifted to another farm in North Canterbury right up to the date at which Mr. Little gave up active work and went into retirement.

As far as can be ascertained, there are no Corriedale descendants as such of the original sheep obtained by the crossing of the Romney and the Merino in Mr. Little's first experiments.

Prior to Mr. Little again taking up breeding operations in North Canterbury towards the end of the seventies, the New Zealand and Australian Land Coy. had commenced breeding Corriedale at the Levels Estate, near Timaru, South Canterbury, and as this flock has been maintained continuously since, it is the oldest Corriedale flock extant to-day.

In 1879, Mr. G. D. Greenwood's flock was started, and at intervals after this period various other flocks were commenced by the breeding of the longwool ram of some breed and the Merino ewe.

In 1926 there were 160 Corriedale flocks registered in New Zealand.

PIGS.

The first pigs in New Zealand were landed by D'Urville, who left two little pigs in Doubtless Bay in 1769. Pigs were also left by Captain Furneaux in 1773 and Captain Cook in 1777. These latter were probably the origin of the wild pigs which exist in certain parts down to the present day.

In his review in 1851 Chas. Torlesse states that pigs were turned out in Canterbury about 1845. They

evidently spread rapidly, as when Messrs. Tripp and Acland took up the first hill run, at the head of the Orari River in 1855, they were told that the country was very rough and fit for nothing but the wild pigs with which it was infested.

The present writer has not been able to trace the dates of introduction of all the different types of domestic pigs. Messrs. Deans Bros. had 20 pigs at Riccarton in 1847 and they were probably Berkshires.

Mr. Laurie Wilson, of Teddington, imported the first Tamworths some 30 years ago.

POULTRY.

The first record the writer can find of the introduction of poultry into Canterbury is when Messrs. Deans, Hay and Sinclair came in the schooner *Richmond* to Banks Peninsula in 1843, as accounts of the voyage state that a few fowls were included in the cargo.

The early ships which arrived from Home brought poultry of different kinds to Canterbury, but possibly in the first place they were mostly of the barnyard type.

However, it was not long before different classes of fancy poultry, geese, ducks, etc., were introduced.

Poultry breeding in Canterbury to-day is in a flourishing condition, and there is a large number of breeders of both fancy and utility types.

BEES.

Humble Bees.

The naturalisation of humble bees in New Zealand is due largely to the efforts of the Canterbury Acclimatisation Society, who desired to introduce this type of bee to fertilise red clover, so that seed could be secured.

A number of humble bees were brought out in 1873 and 1876, and in both instances the bees did not survive the journey.

In a report of the Canterbury Acclimatisation Society of 1880, it is stated that Mrs. Belfield, of Timaru, had secured a shipment of humble bees from Messrs. Neighbour and Sons, England.

The Society asked for *Bombus terrestris* only to be sent, but whilst these are still the most common, still *B. ruderatas* and *B. hortorum* were evidently brought in as well.

The first liberation of the bees in Christchurch was in 1885, and to show how quickly they spread, it may be mentioned, that by the end of the first year, some were found at a radius of one hundred miles from Christchurch, whilst the next year they were found at Dunedin, a distance of well over two hundred miles.

The bees multiplied quickly, and in a short time clover seed growing was successful.

Hive Bees.

In March, 1839, Miss Burnby, sister to the Rev. J. H. Burnby, introduced the first bees to New Zealand when she brought two straw hives from New South Wales to Hokianga.

In 1840, Lady Hobson, wife of the first Governor in New Zealand, brought bees with her from New South Wales.

Mrs. Allum, in 1842, arrived in Nelson with the first bees from England. The writer cannot trace the introduction of the first bees to Canterbury. That they were introduced very early may be gauged by the fact that Lady Barker, in her book on *Station Life in New Zealand,* states that she ate bush honey in Canterbury in 1866.

Canterbury shares with Auckland the honour of introducing the first Italian bees, the Canterbury Acclimatisation Society securing one hive in 1870. The same Society imported four hives of Ligurians in 1880.

The humble bees and the hive bees in Canterbury right from the earliest days of their introduction have done well, and bee-keeping in this Province has steadily expanded over a number of years, and is at present in a good healthy condition.

THE EFFECT OF THE CANTERBURY ENVIRONMENT ON STOCK.

It is an exceedingly difficult matter to gauge the influence of the soil and climatic conditions on the breeds of stock introduced to Canterbury.

The repeated introduction to studs of new blood, often as a result of fresh importations, prevents one from judging the influence of environment on any breed over a long term of years.

Further, the methods of breeding adopted, manner of selection, would, quite apart from environmental factors, markedly alter the characteristics of any breed, within a comparatively few years.

One finds two schools of thought in Canterbury as to whether stock has altered or not in general characteristics, from the original stock introduced.

One school holds that in Canterbury the stock, particularly cattle, have become of a more robust type, with a larger frame and stronger bone, and of better milking capacity. Mr. John Parlane is inclined to hold this view with regard to the Ayrshire breed. The early type, even that of twenty-three years ago, was, he states, smaller than the Ayrshires of to-day, and they had much smaller teats.

However, as already indicated, this may have been brought about more by selection than by environment. Mr. H. E. B. Watson, a very keen student of the Jersey breed of cattle, and of Clydesdale horses, held the opposite view, namely: that any change that may have taken place since the earliest importations, is due almost solely to the manner of breeding, and that environment has played little part in what changes have been made. He considered, however, that stock mature earlier in Canterbury than at Home, due largely to our splendid climatic conditions.

In sheep some breeds are, in Canterbury, very different from the British breeds from which they sprung. Compared with the same breed in England to-day, the English Leicester is a smaller sheep as a rule, but with a covering of better quality well stapled lustrous wool. The Home and Colonial types have

grown right apart, but the present writer believes that this difference has been made almost wholly by selection.

The Canterbury Romney, with its covering of well stapled, crimpy wool, is very different from the Home type, which is, generally speaking, a very big bodied sheep carrying mushy wool, without much character.

The short wool breeds in Canterbury do not appear to differ from the Home types to any material extent.

So far as horses are concerned, Mr. Watson's opinion has been given on the Clydesdale. Although Canterbury is not just as suitable for this breed, from a climatic viewpoint, as Otago and Southland, which more nearly approach the Scotch conditions, still some of New Zealand's best Clydesdales have been bred and developed in Canterbury.

In regard to thoroughbreds, however, the New Zealand bred horses do seem to differ somewhat from the English, but here again this may be due entirely to breeding methods.

A gentleman connected with an English stud, who comes to New Zealand regularly, considers that our horses are bigger at two years old than the English thoroughbred. Others consider that there is little difference between the horses of the same age in the two countries. The English thoroughbred is, on the whole, more aristocratic in appearance than the New Zealand horse, but whether the horses here lose this "classy" look through climatic and soil conditions, or because of different breeding methods, is purely a matter of opinion.

One thing is certain, namely, that every class of stock and every breed introduced to Canterbury has done well. The lessening in popularity of some breeds and the dying out of others has been due solely to the fact that they were not fulfilling an economic function inasmuch as other breeds paid the grazier better.

As a breeding ground for stock of all kinds Canterbury can hold its own with any country, and in sheep breeding, taking the British breeds and the Merino together, it probably leads the world. As the founda-

tion home of the Corriedale—New Zealand's own breed —the Province has achieved a unique distinction, and along with the rest of the Dominion, it is likely to become the Stud Stock Farm of the Southern Hemisphere.

For assistance in the preparation of the above notes the writer wishes to acknowledge his sincere thanks to the following gentlemen:—Messrs. L. G. D. Acland, John Deans, Hugh Reeves, H. E. B. Watson, George Gould, E. J. Ross, J. Parlane, J. I. Royds; whilst the writings of Johannes Andersen, G. M. Thomson, the late James Hay, and the late Hon. R. McNab were a splendid source of reference for much of what appears above.

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